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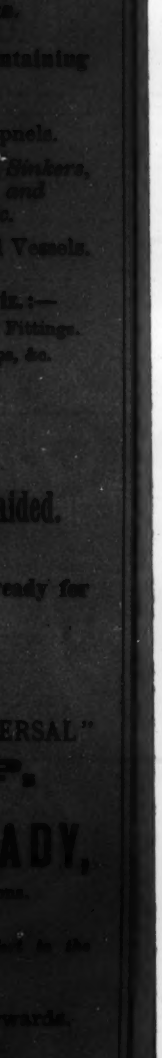

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ECONOMY IN ELECTRICAL CONDUCTORS.*

THE heated discussion which followed the reading of Profs. Ayrton and Perry's valuable paper on electrical conductors clearly showed that on one important subject, at least, the *savants* who listened were not in complete agreement. The rational supposition that there would be found amongst mathematicians but little room for difference of opinion on a subject which admitted of rigorous mathematical treatment, was proved at the meeting of the 11th to be altogether wrong, and the sharp fire maintained between the authors of the paper and their critics across the President's table very soon dispelled any such idea which might have occupied the minds of the members present.

We believe that the carefully written paper of Profs. Ayrton and Perry marks a distinct step in advance of what has been hitherto done. That it will form a valuable contribution to the subject of electro-dynamic transmission we do not doubt, since, to use the authors' own words, it was only on recognising that Thomson's solution of the most economical section to give to a conductor was quite inapplicable in a variety of cases, that they were led to attack the problem from a new standpoint.

We are inclined to think that the want of agreement between the authors of the paper and their critics is due to some misapprehension on the part of the latter. We are quite unable to discern in the reasoning of Ayrton and Perry any very serious ground of complaint, and we think it would be well if critics would endeavour to understand the meaning of a paper before they attempt hostile criticism, which means too frequently an exhibition of their own weakness.

Thomson's law for the most economical section to give to a conductor is doubtless known to most of our readers. The annual cost of transmitting an electric current from one place to another is made up of two quantities; the first being the interest and depreciation on the capital sunk in conductors, and the second being the annual money value of the horse-power wasted in heating the wires. Now, premising that the cost of a conductor per mile increases directly as its area or as the weight of copper in it, and that the waste per mile in transmitting the current is inversely as the area, it follows that for the sum of these two amounts to be a minimum they must be equal to each other. This is Thomson's law, which is capable of graphic demonstration in the following way: along O X let abscissæ represent values of d^2, d being the diameter of the cable. As on the above supposition the annual interest and depreciation cost is of the form $p\,d^2$, let us draw a line from O at an inclination such that ordinates represent to any convenient scale this cost for different values of d^2. The horse-power wasted in the conductor for a given current is inversely proportional to d^2, the annual cost of the power thus wasted depending on the price of coal in the district or on the cost of producing a horse-power at the place where the current is generated. We can determine this cost for any particular current, and a second curve must be plotted in which it is represented by ordinates for different values of d^2. We have now a straight line ascending from O towards the right to represent interest, and an hyperbola descending from the left to represent the cost of waste. The lines will cross at a point where d^2 is such that the two costs are equal to each other, and if a third curve be drawn in which ordinates represent the sum of the two costs, it will be found that the value of d^2, for which the sum is a minimum, corresponds with that at which the two costs are equal to each other.

But Thomson's law is true only on the assumption above made of the cost of conductors being proportional to d^2. Although Ayrton and Perry, in common with other writers on the subject, make the same assumption it is easy to see that this but very inadequately represents the true cost of supplying and putting down the mains. As a matter of fact, the curve which correctly represents the interest for different values of d^2 is more or less complicated, and alters its form for every district. Approximately it might be taken as a straight line where the ordinates have the value

$$m + p\,d^2,$$

m being a constant, which represents the interest on the capital paid for rights of way, spent on earthenware troughing for cables, breaking up streets, making the same good again, &c.

We have said that Thomson's law does not apply for a case like the above, and this can easily be shown from the curve we have just drawn. Allowing p to have the same value as before, let us, without altering its inclination, move the interest line upwards by an amount equal to m. To obtain the curve representing the sum of the two costs under this new condition the ordinates of the curve which formerly represented this must be lengthened by an amount equal to m. The total cost will now be shown to be a minimum when d^2 has the same value as before, but *for this minimum value the interest on the cost of conductors will no more equal the cost of the energy wasted in conveying the current, the former being greater than the latter and the disproportion depending on the value of* m. This is the case which is constantly recurring in electric lighting, and here Thomson's law, as ordinarily stated, gives us no guide. What we have to do is to determine for the particular district we are dealing with the interest cost for different values of d^2 and to draw, combined with

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[*] "Economy in Electrical Conductors." A paper read before the Society of Telegraph Engineers and Electricians, by Profs. W. E. Ayrton, F.R.S., and John Perry, F.R.S., on March 11th, 1886 (see ELECTRICAL REVIEW for last week).

the interest curve so obtained, the waste curves for the different currents we mean to employ. By plotting a series of curves to represent the sums of the two we can then determine the most economical section of conductor for any current, and, conversely, the most economical current for any section.

But we pass from considerations respecting Thomson's law to consider the problem solved by Ayrton and Perry. The law above referred to does not concern itself with the length of the conductor, nor with the power actually transmitted through it, but confines itself simply to the statement of a well known mathematical truth. When, therefore, the problem arises in which a definite amount of power has to be delivered at a certain distance from a generator, the difference of potential at the terminals of which is fixed, the law given by Thomson does not help us to a solution. This is the problem which has been solved mathematically by Ayrton and Perry, and, in this case, it is conditioned by both the difference of potential, V, at the terminals of the dynamo and the power in watts delivered at the end of the line being given. C, the current, and r, the resistance of the line, are two variables, and the problem is to co-relate C and r to each other so that under the conditions fixed by V and P the total cost of the transmission will be a minimum. In Thomson's solution the current was given and r was the sole variable; here it will be seen the problem is altogether different, and the law of economy which there applied is not the law which must be followed to obtain the best result under another set of conditions. The resistance of the line is inversely as d^2, but, as we have not before used r, it will simplify matters if we consider the line of such length that its resistance may be taken as the reciprocal of d^2. This corresponds to a length of about fifteen miles. That the power, P, may be transmitted with a difference of potential, V, at the dynamo, d^2, and C must always be related to each other so that

$$\frac{C}{d^2} = V - \frac{P}{C}$$

or

$$d^2 = \frac{C}{V - \frac{P}{C}}$$

In the case selected as an example by the authors of the paper, V is taken as 200 volts and P as 10,000 watts. Returning to our graphic method we can, by inserting values of C, find d^2 for each particular current, and from these plot a curve in which d^2 are represented as abscissæ and C as ordinates. The curve so plotted is a peculiar one. Approaching from the right with a slight upward inclination it bends over at some distance from O. Y. and returns to the right with a much steeper upward slope, thus revealing the fact that there are for each value of d^2 two values of C by which the above equation of transmission is realised.* For example, if C is made 300 ampères

$$d^2 = \frac{300}{200 - \frac{10,000}{300}} = 1\cdot 8$$

also if C is made 60 ampères

$$d^2 = \frac{60}{200 - \frac{10,000}{60}} = 1\cdot 8.$$

Again with C = 200 ampères

$$d^2 = \frac{200}{200 - \frac{10,000}{200}} = 1\cdot\dot{3}$$

or C = 66·66 ampères

$$d^2 = \frac{66\cdot 66}{200 - \frac{10,000}{66\cdot 66}} = 1\cdot\dot{3}$$

With these currents and values of d^2 we have:

For 300 ampères—

Received $300 \times 200 = 60,000$ watts.

Wasted $\frac{300 \times 300}{1\cdot 8} = 50,000$ „

Transmitted $= 10,000$ „

For 60 ampères—

Received $60 \times 200 = 12,000$ watts.

Wasted $\frac{60 \times 60}{1\cdot 8} = 2,000$ „

Transmitted $= 10,000$ „

For 200 ampères—

Received $200 \times 200 = 40,000$ watts.

Wasted $\frac{200 \times 200}{1\cdot\dot{3}} = 30,000$ „

Transmitted $= 10,000$ „

For 66·6 ampères—

Received $66\cdot 66 \times 200 = 13,332$ watts.

Wasted $\frac{66\cdot 66 \times 66\cdot 66}{1\cdot\dot{3}} = 3,332$ „

Transmitted $= 10,000$ „

From these figures it will be observed that there are any number of relations between the current and line resistance by which P can be delivered at one end, but we are not in a position yet to say which is most economical. From the curve already drawn we must plot another curve in which is represented, by ordinates drawn to any convenient scale, the annual cost of the power wasted for different values of d^2. We must also draw a curve to represent the interest for different values of d^2, when finally, by a curve showing the sum of the two, we can tell at a glance the particular value of d^2 which renders the total annual cost a minimum.

The curve we have obtained will represent the cost for one particular length of line wire only, and the question arises, how must a curve such as we have described be modified to obtain the cost for a different length of conductor? Let it be remembered that the relation between the current and resistance depends on V and P. It is independent of the length of the line through which the power is transmitted, and in the event of our making the line n times as long, d^2 must be made for each current n times greater that the relation between current and resistance may still hold good. Now, if the line is n times as long, for a value of d^2 n times greater, the resistance, the current, and the heat waste will be as before if the same power is to be transmitted, and we must therefore lengthen the abscissæ of the curve representing this n times, that the waste may be represented under the new condition for the different values of d^2. As regards the interest on the cost of conductors, it is evident that the ordinates of the interest curve must be increased n times, since the line is n times as long. By plotting a curve representing the sum of the ordinates of these two curves as modified, we obtain one which shows how the total annual cost depends on d^2. The facts revealed by the paper of Profs. Ayrton and Perry are completely borne out by the results obtained from the graphic methods we have described, and, to quote the authors, *if a given amount of electric power has to be furnished at the end of a line, with a given difference of potential at the dynamo, maximum economy is obtained, not by keeping the current density constant, but by making it diminish as the length of the line becomes greater. In all problems connected with*

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* Excepting in one particular case which corresponds to the point on the extreme left of the curve where it bends over to return. In this case $d^2 = 1$ and C is 100 amps., half the total power put in being wasted in the conductor.

the transmission of power where the maximum potential is given, a current smaller than given by Thomson's formula must be used to obtain maximum economy. This is clearly shown in Table I., where the figures have been calculated for a transmission of 20,000 watts with a potential of 200 volts.

We have been at some pains to place before our readers a graphic method of solving some of the problems mathematically dealt with in the paper under review, and for several reasons. As we have before stated, the cost of supplying and placing conductors underground, or even for erecting them overhead, does not depend simply on the weight of copper, and probably alters its amount relatively to the weight for every different locality. But the interest and depreciation on any line can be most conveniently plotted in a curve for different values of d^2. Again, under certain relations of d^2 to the interest cost, the curve for the total annual cost shows that the minimum is practically constant for a considerable variation of d^2, and when this is the case it will be a question depending on circumstances whether the waste in heating or interest is to be greatest. From the curves we can see at a glance how the total sum is made up, and if the installation is to be temporary, obviously it might often pay better to keep the specialised capital account low at the expense of using more coal per annum.

Profs. Ayrton and Perry in the concluding part of their paper offer further solutions respecting the most economic section to give to steel rails for telpher lines and to electric railway conductors. The solutions given for these special applications of electro-dynamic transmission are extremely instructive, but we believe that the more convenient way of solving such problems will be by graphic methods, where the actual interest cost of conductors must be plotted for each district. Be this as it may, the paper in question clearly reveals the way in which must be attacked in the future problems of the kind they have dealt with. Their contribution to the subject is one of value, and we are certain that it will meet with the appreciation it deserves from all electrical engineers.

CORRECTION OF AN ERROR IN ELECTRO-DYNAMICS.

IT is not unfrequently supposed, says Prof. W. L. Hooper in the New York *Electrician and Electrical Engineer*, that there is an expenditure of energy in the coils of an electro-magnet sustaining a load or in a coil of wire containing an iron core other than that due to the resistance *per se* of the wire.

The above is plainly stated in at least one somewhat prominent book on electricity with which I am familiar, and given as an illustration of the conservation of energy. Some months ago I undertook, with the assistance of one of my students, the investigation of this phenomena.

A tangent galvanometer with a coil having a diameter of about two-thirds of a meter consisting of five turns of stout wire was improvised. A piece of magnetised watch spring, 1 cm. in length, attached to the back of a small mirror hung by a silk fibre in a tight box constituted the needle. Deflections were read with a lamp and scale 1 m. distant. The battery, galvanometer and electro-magnet formed a simple circuit.

Owing to the facts that the needle was sometime in coming to rest and that the battery was not absolutely constant, changes in the current strength less than a considerable fraction of 1 per cent. could not certainly have been detected.

We accordingly tried another plan and made the electro-magnet one of the four resistances of what was practically a Wheatstone bridge arrangement. We were here troubled greatly by the unequal heating of the various conductors by the strong current used; nevertheless, if the apparent change in resistance of the electro-magnet when lifting a load had exceeded a few hundredths of 1 per cent. we should have detected it.

The same was true of a coil of wire with an iron core; no change due to the iron core was suspected.

It was here resolved to renew the experiments on the completion of a divided meter bridge then projected. The subject was accordingly again taken up a few weeks ago.

The slide wire of the bridge is a meter in length, the prolongations used in the side gaps were a little less and a little more respectively than 41·5 m. of the slide wire; hence the equivalent slide wire was about 84 m. in length. The electro-magnet was placed in one of the central gaps, in the other a nearly equal resistance carefully selected, so that the heat developed by the current should affect both alike.

The battery used consisted of six large bichromate dip cells having an electromotive force of 11·8 volts and an internal resistance of ·3 ohms. After some preliminary experimenting the following order was adhered to. After closing the battery circuit the armature with a load of about 65 lbs. was placed upon the electro-magnet; the man at the Thomson reflector in an adjoining room was then directed to close the galvanometer circuit, if necessary the bridge was adjusted till the spot of light stood steadily at zero.

The galvanometer circuit was then broken and immediately afterwards the battery circuit was opened, when the armature fell off; the circuits were then quickly closed in the inverse order and the deflections observed. After several precautions, unnecessary here to relate, had been adopted, the above could be done without any perceptible motion of the spot of light.

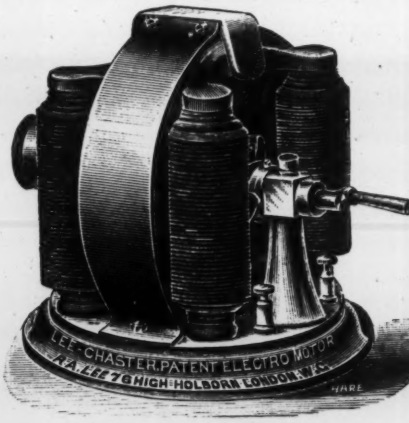
It will be remembered that the equivalent length of the slide wire was 84,000 mm.; now a motion of 1 mm. of the pointer was found to give a deflection of a little over three divisions on the scale of the galvanometer.

Hence it is not too much to say that if anything much exceeding the one-millionth of the energy of the current had been absorbed in doing work upon the armature of the electro-magnet, it would have been detected.

Of course, in the light of the modern theory of electro-dynamics the result could not have been otherwise; still, it seems to me important to correct mistakes by an appeal to experiment wherever possible.

THE LEE-CHASTER MOTOR AND BATTERY.

THE Lee-Chaster patent electro-motor, which we illustrate, is made by Mr. R. A. Lee, of 76, High Holborn, W.C., and can be seen at his works applied to one of his ingenious shaping machines. Although occupying a space of 8 in. by 8 in. only, it is said to be capable of


LEE-CHASTER PATENT ELECTRO MOTOR
R.A. LEE 76 HIGH HOLBORN LONDON W.C.
HARE

developing energy equal to nearly ¾ H.P., and can be started, stopped, or reversed by the simple movement of a switch. The device is more especially worthy of notice because it is driven by a battery which involves the minimum of trouble, which will run for about 20 hours without recharging, and can then be restarted with fresh solution in a very short time. The cells are charged with Lee's new double bichromate, which is soluble in its own weight of cold water, and which does not deposit crystals in the pores of the carbons or in the cells. Moulded corrugated carbons are used, and the zincs are so cut as to economise the metal as much as possible. The cells rest on a tray in a box, which tray can be raised by means of a treadle until the elements are fully immersed in the solution. Both zincs and carbons are suspended from a board, which forms a lid, so to speak, and the connections are made by means of brass plates, thus avoiding the use of wires. Two wing nuts hold this board to the mechanism of levers, and by removing them the whole battery of elements can be lifted out, leaving the cells exposed. The zincs and carbons are automatically removed from the solutions when the treadle is released, and the amount of immersion can be regulated to a nicety. We understand that preparations are being made for fitting a Lee-Chaster motor to a launch—work to which both motor and battery are well adapted.

CENTRAL ELECTRIC LIGHTING AT TOURS.

SOME months ago, writes M. Hospitalier in *La Nature*, we called the attention of our readers to the difficulties attending the distribution of electrical energy over a somewhat extensive radius from a common centre of distribution, and gave reasons justifying the employment of transformers. We will now briefly show their object. In order to diminish the loss of energy in an extensive canalisation without using large, cumbersome and expensive conductors, the current must be reduced as far as possible, and this involves the employment of high tensions and high potentials. But these high potentials are not directly practicable, and it is impossible to place them at the disposal of consumers, as they are very dangerous. These currents must therefore be modified or *transformed*, their electromotive force reduced and their volume increased, so as to suppress the dangers involved in their use, and render them directly practicable in the various applications of electricity of the present day; this is the object of *transformers*. We may even go so far as to assert that, at present, the *transport* of electrical energy at a high potential is incompatible with the *distribution* of the electrical energy so transported without the aid of transformers; it is upon the choice of transformers that opinions are divided. Some, like M. Marcel Deprez, seek to utilise the motive force produced at a distance, which force can there be employed in actuating electrical generators of less tension and greater current destined to effect a distribution over a smaller area.

It is very certain that even in the very improbable case of motive power being economically transported by the aid of continuous currents at a tension of 6,000 volts, the problem of the distribution and division of this force would still remain unsolved. We cannot, besides, entertain any great hopes of the utilisation of great natural forces at a distance, when we take into account the cost of installation, inevitable losses, the complications of the system, and, lastly, the instability of natural forces. In proof of this instability, we may mention that in the lighting of Lucerne by electricity by the Zipernowsky-Déri system, a steam engine of 250 H.P. is in reserve in order to provide against possible stoppages of the water power. Some experimentalists, like Messrs. Gaulard and Gibbs on the one hand, and Messrs. Zipernowsky, Déri and Blathy on the other, effect the transport by the aid of alternating currents of high tension, and the distribution by employing transformers. Others (and it is this system that is now being carried out at Vienna) effect the *transport* by the aid of a continuous current, the groups of accumulators being charged in series, and the distribution by means of these accumulators grouped in such a manner as to reduce the potential in the canalisation of distribution.

This last system is, in our opinion, by far the best, if we take into account the improvements yet to be made in accumulators. The continuous current allows of more varied applications than alternating ones; the accumulators, which in this particular case are only deferred transformers, enable the time of production to be separated from that of utilisation, and eventually allow of a maximum consumption far above the power of production of the works, and even provide against a complete stoppage of the works, thus offering the greatest security to consumers.

We will not, however, now discuss the continuous current distributions by means of accumulators and the future that awaits them, but confine ourselves to the present, and to M. E. L. Naze's interesting application of transformers to the lighting of the City of Tours. The central works are established on the Place du Palais de Justice, at one of the extremities of the Rue Royale, and the principal canalisation, which extends as far as the banks of the Loire, is about one kilometre in length. A distribution of this extent would have required a very expensive canalisation to maintain a constant and uniform potential throughout its length. It is, however, indispensable that this potential should remain constant, as we may see by the fact that an Edison lamp, working normally at 100 volts and producing 16 candles, gains or loses one candle per volt more or less. A difference of 4 volts, at different moments, would therefore cause a corresponding difference of 4 candles, or the fourth of the normal luminous power.

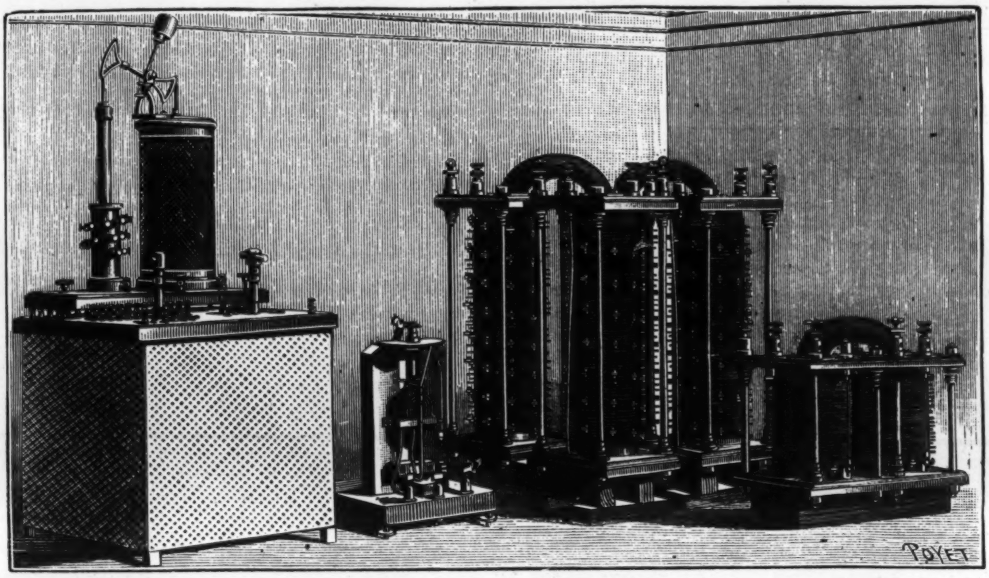
In order to avoid these variations of potential which are so prejudicial to the quality of the light, and also to the duration of the lamps, M. Naze employs a method which consists of establishing two distinct systems; a system of transport of 850 volts, feeding a certain number of transformers, the induced circuits of which supply a system of distribution, special to each one, and independent of one another, distributing at 50 volts only.

The motive power is produced by two compound or two-cylinder steam engines (Weyher and Richemond). In installations of this kind, engines with two cylinders are preferable to engines of long expansion in a single cylinder, because the motive couple being more constant, the variations of speed in each revolution become inappreciable. One of these engines has a nominal power of 100 H.P., the other of 150. They each drive a separate counter-shafting, which actuates a generating machine and its exciter. This arrangement of the engines enables them to work either separately or together as required.

The generating machines are on the Siemens system with alternating currents, type W_{100}. They each bear 30 bobbins, 28 only of which are used, the two others remaining in open circuit. The 28 bobbins used are coupled 7 in series and 4 parallel. At 550 revolutions per minute and an excitation of about 25 ampères, the machine produces 66 ampères and 850 volts at the terminals. With a total excitation of 40 ampères, the same coupling will give the same current, with 1,250 volts at the terminals, representing 82,500 watts or 112 electrical H.P. At 850 volts, the machine produces at present, when in full action, only 56,000 watts or 75 available electrical H.P.

Each machine supplies one side of the street. The transformers are arranged at certain points on the principal branch, and connected in parallel, as in the Zipernowsky system. One of these transformers is shown towards the right of the fig.; this is the one employed at the works in the measuring and regulating room, where it serves both to light the works and to show the good working of the system. It consists of four columns, the cores of which are coupled two by two, so as to constitute a closed magnetic circuit.

The inductive and induced circuits are constituted of copper discs soldered together and separated by sheets of asbestos. The four inductive circuits of four columns, forming a transformation group, are connected in series; the four induced circuits are joined up in parallel. The coupling of the discs in each column, and of the columns together, is such that a difference of potential of about 825 volts at the terminals of the primary circuit of a transformer keeps up a difference of potential of 50 volts only at the terminals of the secondary circuit, whatever may be the number of lamps lighted at each moment from zero up to a maximum of 250 ampères, representing the power of a four-column transformer. Under these conditions, each apparatus not distributing for more than 100 to 150 metres all round it, the loss of pressure in the branch is very slight, and the distribution is ensured by the aid of 48 volt lamps. The 16-candle lamps take about 1 ampère, the lamps of 10 candles 0·6 ampères, which amounts as near as possible to 3 watts per candle for either type.



Potential Regulator. Electro-Dynamometer. Four-column Transformer. Little Transformer.

Fig. 1.

Each column represents 4 H.P. of distribution, or 16 per group of four columns. When the distribution is at 1,250 volts, each group constituting a transformer will have six columns, and will be capable of distributing 24 H.P. under a potential of 50 volts and a current of 375 ampères.

In order to verify the potential at the terminals of each generating machine, for want of an industrial and practical voltmeter for the measurement of alternating currents, 17 incandescence lamps of 50 volts are employed, connected in series and placed as a shunt from the terminals of the machine.

On closing the circuit on these 17 lamps, they burn at their normal power if the potential is normal; they are somewhat feeble if the potential is too low and somewhat brighter if the potential is too high. They form a very reliable galvanoscope, the only defect being that more than one electrical H.P. is used for the measurement during the time that the current is closed upon the lamps.

The potential is kept constant at the terminals of the machine, whatever may be the expenditure in canalisation, by variable resistances being introduced into the circuit of the exciter. This regulation is now performed by hand. When the potential in the transport canalisation reaches 1,250 volts, the regulation is effected automatically by the aid of an apparatus shown at the left of the fig. This regulator consists of a balance beam, from the extremities of which are suspended two iron cylinders; one of these cylinders is placed in the middle of a solenoid of fine wire; the other dips into a cavity containing mercury. The more or less powerful attraction of the solenoid inclines the beam more or less, and causes the other cylinder to plunge more or less deeply into the mercury. It also produces a change of level in this mercury, which is turned to account in introducing a variable resistance into the exciting circuit. The sensibility of the apparatus is regulated by displacing a counterpoise which is movable on a vertical rod fixed upon the beam. Thus the variations of potential at the terminals of the machine are limited, and it is kept practically constant.

Such are the principal features of the Tours installation. There are still many details left to describe as to the manner of reckoning the light used by consumers, the measurers of electricity in the study, the auxiliary transformers which re-transform the current of 50 volts and bring it to 100 volts to feed two arc lamps in tension, &c. (One of these transformers is shown at the right of the fig.). What we have said will suffice to show the advantages that have been drawn from M. Gaulard's transforming apparatus in their application to a distribution of the electric light.

A long trial will show the advantages and defects of this system; but, in any case, we are pleased to note the successful and intelligent initiative that has been given in this direction.

ELECTRICAL DISTRIBUTION.

Prof. George Forbes has written to the *Journal of the Society of Arts* respecting his recent paper on the above subject as follows:—On reading over the paper which I read to the Society of Arts on February 17th last, "On Some Points in Electrical Distribution,"[*] I find that, when speaking of secondary generators, there is an omission which may be apt to mislead. When treating of the arrangements of these generators *in*

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[*] See Electrical Review for February 26th, 1886.

parallel, my remarks in the body of the paper have reference only to such generators as those which have been specially under my notice—where the difference of potential at the terminals either of the primary or secondary circuit is not so great as thousands of volts. I feel that I ought to have taken some notice of those generators in which the difference of potentials of the primary may be several thousand volts. In this case, of course the fall of potential in the main conductors is of far less moment. There a distance of a mile causes as little trouble as does 100 yards in a direct supply. The ratio of the maximum values of the difference of potentials at the terminals of the primary and secondary coils may be expressed by the following relation :—

$$\frac{V^2}{V'^2} = \frac{\rho^2 + 2\rho\, r' + r'^2}{\rho'^2 - 2\rho'\, r' + r'^2} + \frac{\rho^2\, r'^2}{(\rho'^2 - 2\rho'\, r' + r'^2)\, C^2}$$

Adopting the same notation as in the appendix to my lecture.

Now, r' is always very large compared with ρ', and ρ is large compared with r' in the present case. Hence, this reduces to $\frac{V^2}{V'^2} = \frac{\rho^2}{r'^2} + \frac{\rho^2}{C^2}$ approximately.

If C^2 be small compared with r'^2, then we might have $\frac{V^2}{V'^2} = \frac{\rho^2}{C^2}$ a constant. Hence it appears that, with a generator the resistance of whose secondary circuit is large, and the resistance of the primary coil large even when compared with that, we may attain a constant E.M.F. in the lamp circuit by maintaining constant pressure at the terminals of the primary, and (in the case where the E.M.F. of the dynamo is very great) this may be attained by keeping the E.M.F. at the terminals of the dynamo constant.

I have seen no experiments to judge how far this approximation has been reached in actual practice, but I have been promised to inspect such an arrangement shortly.

P.S.—Please notice the following erratum in the appendix to my paper. In the expression for V'^2—*for* $(r' + \rho')^2$ *read* $(r' - \rho')^2$.

"SELF-INDUCTION:" OR, THE EFFECTS DUE TO THE ELECTRO-MAGNETIC CAPACITY OF CONDUCTORS.

By DESMOND G. FITZGERALD.

IT would de difficult to overrate the importance—from a theoretical no less than from a practical point of view—of the questions raised by Prof. Hughes's admirable paper on "The Self-induction of an Electric Current in relation to the nature and form of its Conductor." Nor has the fact that these questions have been generally neglected—that the researches of Prof. Hughes are of almost startling originality—been sufficiently recognised. Due acknowledgement was made in the paper of the valuable labours of M. Gaugain in relation to the *variable periods* preceding and following the normal passage of a current; but, so far as I am aware, the French physicist has considered only the electro-static conditions prevailing during these periods, and did not take into account the effect of retardation due to what is termed "self-induction" or "the induction of a current on itself."

Now I may at once state, with every deference to Prof. Hughes, and also to Prof. Faraday—an investigator of the same order of mind, with whom the expressions just made use of originated—that one of the main objects I have in view in these observations is to quarrel with the terms in question. I maintain that they originated in a complete misconception of the nature of the phenomena which are also said to be due to "electro-magnetic inertia;" and that, in the present condition of our knowledge, they should be considered as obsolete. I would further deprecate the use of the term "inductive capacity" of conductors in the same sense as "electro-magnetic inertia" on the grounds that it is likely to lead to confusion; this term being already employed not only to correctly designate a property of dielectrics, but also to signify what should properly be expressed as the electrostatic or "charging" capacity of conductors under given conditions. According to my view, the phenomena ascribed to "the induction of a current on itself" are entirely due to the *electro-magnetic capacity* (or *resistance*, if we prefer to take the reciprocal of capacity) of a circuit, or of a conductor, under given conditions. Moreover, in the variable period preceding the passage of the normal current, the effects supposed to be due to the induction on itself of the current in reality *precede* its passage, being consequent upon the establishment of conditions which are essential to conduction. At least this conclusion is consequent upon the admission that the maximum of magnetisation, under the given conditions, must exist in the conductor before the normal current can pass; for, under the same law, *some degree* of magnetisation would be a condition necessary to the passage of *any* current.

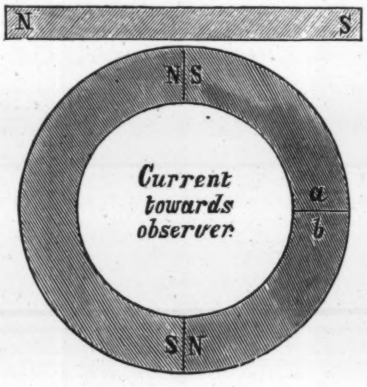

FIG. 1.

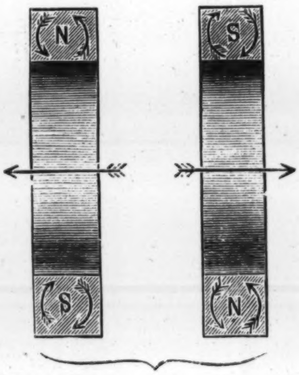

FIG. 2.

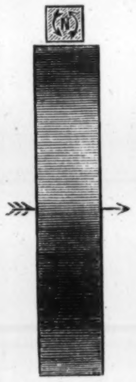

FIG. 3.

In the *Electric Telegraph Review* for August 27th, 1870, I published the results of an investigation I had made of "the Magnetic polarity of conductors conveying an Electric Current." The following diagrams are taken from my paper under that heading; and it will be seen that they represent transverse slices of a conductor conveying a current—the central portion of the sections being removed in order to exhibit the analogy between such transverse sections and a closed magnetic circuit formed of two "horse-shoe" magnets with their opposite poles in contact. I will assume for the present that it is generally known and admitted that the magnetic polarity of all conductors conveying a current is as here represented, and that if, for instance, the hollow cylinder shown in Fig. 1 were cut through the line between *a* and *b*, a north pole would appear at *a* and a south pole at *b*. And I need not here point out that, in the case even of a closed magnetic circuit, there exists a magnetic field external to the magnets; nor that the polarity shown, taken in conjunction with the fundamental law that "currents in the same direction attract, and currents in opposite directions repel, each other," affords a simple and unerring explanation of all the phenomena of attraction and repulsion between currents and magnets.

But one fact which may here be usefully referred to is that—although the electro-magnetic effect is greatly increased by giving to the conductor the form of a helix or coil, and is still further augmented by inserting a magnetic substance within the latter—a rectilinear conductor conveying a current is an elementary electro-magnet, similar in polarity to the coil with, or without, its core, and consequently tending to induce in the conductor an *inverse* current, *i.e.*, one in the direction opposite to that of the current which is said to generate the magnet. Now an electro-magnet cannot be generated without an expenditure of energy; it has in fact stored up in it the sometimes strikingly-considerable quantity of energy which re-appears in the induced *direct* current, or "extra current," during the variable period *following* the normal passage of the current. The question arises: Whence is this energy derived? An answer which, *primâ facie*, may appear equally simple and satisfactory, can be given to this question. The energy is derived from the battery, or other source of electrical supply, in the circuit. Whenever, as in this case, an opposing electromotive force is overcome, some portion of the work done by the current necessarily becomes stored as potential energy. For instance, let a given (normal) current, C, be diminished to $\frac{\mathrm{C}}{2}$; firstly, by the insertion of a resistance (R becoming $2\ \mathrm{R}$), and, secondly, by means of an opposing E.M.F., $e = \frac{\mathrm{E}}{2}$. In case 1, the work, $\mathrm{C\ E}$, done by the normal current in a given time becomes $\frac{\mathrm{C}}{2}\ \mathrm{E}$, and the energy expended in heating the conductor is $\left(\frac{\mathrm{C}}{2}\right)^2 2\ \mathrm{R} = \frac{\mathrm{C}^2}{2}\ \mathrm{R}$. But $\frac{\mathrm{C}^2}{2}\ \mathrm{R} = \frac{\mathrm{C}}{2}\ \mathrm{E}$ (since $\mathrm{E} = \mathrm{C\ R}$); therefore, the whole of the work done by the current is expended in heating the conductor. In case 2, the work done by the current becomes $\frac{\mathrm{E} - e}{\mathrm{R}}\mathrm{E} = \frac{\mathrm{C}}{2}\ \mathrm{E}$, as before; but the energy expended in heating the conductor is now $\left(\frac{\mathrm{C}}{2}\right)^2 \mathrm{R} = \frac{\mathrm{C}^2}{4}\ \mathrm{R}$, or half the former value; therefore, only half of the work done by the current is expended in heating the conductor. The remaining half, if it does not appear as mechanical work, usually becomes stored as some form of potential energy. Although, for the sake of simplicity, I have, in this example, taken only one value for e (which may represent the E.M.F. of the inverse current), it will be seen that, if this value vary from $e = \mathrm{E}$ to $e = 0$, the energy expended in doing electro-magnetic work in the conductor will be the sum of the differences, during the variable period, of the successive values for total work and work expended as heat.

"Well! and what more," I may be asked, "can you require in explanation of the origin of the energy expended in doing electro-magnetic work upon the conductor? Can you deny the probability of the answer to the above questions which you have imperfectly sketched out, and would you resort to some far-fetched hypothesis of heat disappearing in the circuit in order to explain what is already so clear?" Bear with me a moment, please! I am no mathematician, and I have a weakness for endeavouring to represent to my "mind's eye," physically, what really does take place in a phenomenon so interesting as that of the *birth of magnetism.* I have some reason for thinking that what constitutes magnetism constitutes also the *modus agendi* of electrical conduction. Now, according to the above explanation, the current from the battery, overcoming the back E.M.F. in the conductor, during the variable period preceding the passage of the normal current, expends a portion of its energy in doing electro-magnetic work, *i.e.*, in generating magnetism. But can a current pass in a conductor prior to its becoming magnetic? If so, a conductor conveying a current is not necessarily magnetic. In the contrary case, the magnetic condition, at least initially, cannot be produced by the passage of the current. You see that, from my point of view, the explanation is defective or insufficient.

Let us drop this point and see if we can find, in other directions, not a theory, nor even perhaps a complete hypothesis, but suggestions for an hypothesis of conduction, involving the production of electro-magnetic work, and the appearance of magnetism, prior to, or simultaneously with the initial effect of conduction.

In the halved section of a hollow cylindrical conductor, shown in fig. 2, the circular currents indicated may be taken as those of Ampère's theory; but with a very important difference. During the last sixteen years I have repeatedly pointed out that Ampère's theory of magnetism is defective and illogical in one particular. He ascribes all magnetic effects to circular currents of electricity; whence it follows that such currents must exist in a rectilinear conductor conveying a current. So far we can go with him; but no farther. We may admit that the convolutions of a helix are the seat of two kinds of circular currents; but we cannot admit that *both* these, if *straightened out*, would still exhibit magnetic effect due to the attractions and repulsions between circular currents. We arrive immediately in fact at a *reductio ad absurdum*—an infinite number of circular currents within each circular current in a rectilinear conductor. It will be seen that, whereas Ampère's circular currents, if straightened out, would resemble other circular currents in exhibiting magnetic effect, we require, before we can accept the theory as physically true, to know of *a circular current exhibiting magnetic effect, which current, when "straightened out," will no longer exhibit magnetic effect.*

So long ago as July 3rd, 1868, I published in the *Engineer* a communication "On the production of a continuous electromotive force by the motion of a conductor in proximity to a static electrical charge," illustrated by the following diagram:—

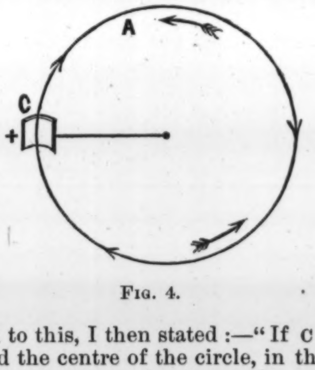

FIG. 4.

In relation to this, I then stated:—"If C be made to revolve round the centre of the circle, in the direction of the arrow-heads upon the circumference, the current, if the cylinder be positively charged, will be in the same direction as the motion of C, and the ring, A, will become a magnet having its south pole facing the observer."

Following the clue I had then obtained, and working with the very imperfect means of investigation then at my command, I was able to mention, in the above-mentioned issue of the *Electric Telegraph Review* (August 27th, 1870), that "it has been proved experimentally that the revolution of a charge, or the rotation of a conducting body in the vicinity of a charge, produces the magnetic effect of a circular current." I was afterwards led to admit that the *sign* of the charge has no effect upon the magnetic polarity consequent upon rotation in a given direction, This being understood, we may now regard the circular currents indicated in fig. 2 as the resultant of the rotation of molecules, one component of which, or one portion of the surface of which, is electrically charged.

At the present period, when the fact that "heat is a mode of motion" may be said to be universally recognised, and when the absence of molecular motion is clearly seen to imply the "absolute zero of temperature," few will have any difficulty in realising as a physical truth that "all matter is composed of atoms, or of molecules, not in actual contact, but surrounded by interatomic or intermolecular space." "Space," says Faraday, "must be considered as the only continuous portion of a body so constituted. Space will permeate all masses of matter in every direction like a net, except that in place of meshes it will form cells, isolating each atom (or molecule) from its neighbours, itself only being continuous."* But, argues Faraday, if space be an insulator there can be no transmission of electricity from atom to atom; whereas, if it be a conductor, it cannot exist in insulating bodies. Since the period when Faraday made this incautious statement, it has been shown, and I think conclusively, that vacuous space does not conduct electricity. And, I suppose, it will be readily granted that "if space be an insulator, but if a conducting atom charged with electricity can move through space into contact with another conducting atom, then there can be a transmission of electricity from atom to atom."

But why should one component only, or one portion only, of a molecule, forming portion of a conducting mass, receive an electrical charge? In the case of electrolytes, the question is readily answered; for it is a well-established law that "Those bodies only are electrolytes which are composed of a conductor and a non-conductor."

But how is this question to be answered in the case of simple conductors? I am forced to admit that I am not in a position to answer it conclusively in this case. I can only suggest that simple conductors and all the elementary bodies are analogous in their constitution to electrolytes; the molecules being formed of an electro-positive constituent capable of becoming electrically charged, and an electro-negative constituent which, under certain conditions of union with other molecules, is not susceptible of becoming so charged. But, in support of this suggestion, I may refer to the very interesting researches of Brodie (*Phil. Trans.*, 1850, 759, and 1862, 837), and also quote the following statement of an investigator—the late Prof. W. Allen Miller—whose premature decease was an irreparable loss to science and to those who had the privilege of knowing him.

"It is highly probable," says Dr. Miller, "that the isolated bodies usually viewed as elements should be regarded as compounds, the molecules of which consist of particles of the same element in opposite polar or electrical conditions. Hydrogen gas, for instance, is to be regarded as *hydride of hydrogen*, or a compound of hydrogen with hydrogen; chlorine gas as *chloride of chlorine*, and so on." Copper would thus be *cupride of copper*; iron, *ferride of iron*, &c.

I may briefly point out that the charged component of a molecule forming part of a conductive circuit, and also, necessarily, of an inductive circuit, would tend to move *outwards*, radially, rather than in the direction in which it would carry the charge towards the axis of conduction. Further, it may be assumed that the molecules of a conducting body in its normal condition, which molecules would have only their normal electrical charge, move or rotate in every possible direction; whereas these molecules, when the conducting body is conveying a current of electricity, *after the expiration of the variable period preceding the passage of the normal current*, rotate only in radial planes parallel to the axis of conduction.

With these explanations, I may now give a diagram representing a section through the axis of conduction of a "wire" of electrolyte, viz., sulphate of copper solution, and which more or less crudely expresses my notion of the *modus operandi* of conduction, both in electrolytes and in simple conductors, during the stable period of the passage of the current.

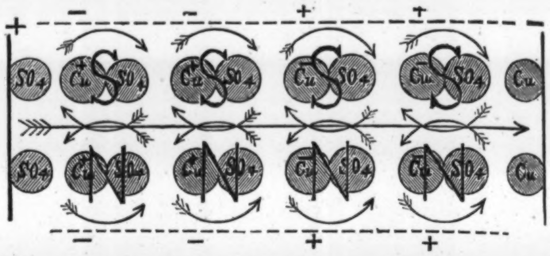

FIG. 5.

At the commencement of the variable period preceding the normal passage of the current, the molecules, I assume, are moving (rotating) in every possible direction. The observed first effect of the electromotive force of the source, brought to bear on the conductor, occurs in the inductive circuit; in the case of a coiled cable, for instance, the "current of charge" passes *instantly*, deflecting a galvanometer, placed between the source and the cable, in the same direction as that in which it is subsequently deflected, after the return of the needle to zero, by the normal current.* I shall not attempt the explanation of this phenomenon of the instantaneous passage of the current of charge—which is one of the interesting questions suggested by Prof. Hughes's paper—further than to observe that this current of charge, tending laterally, may possibly be conveyed by the moving molecules before the conditions for the longitudinal passage of the normal current are established. The next effect of the E.M.F. is, probably, to "polarise" the molecules, or to cause them to move in planes parallel to the axis of conduction; and the next is to arrest, and then to reverse, the motion of the molecules rotating in the direction opposite to that indicated in the diagram, and thus tending to transmit electricity in the direction opposite to that of the normal current. It is to be observed that the temporary arrestation of the motion of *molecules* would be attended by a temporary diminution of temperature.

I have great difficulty in representing to my mind the cause or causes of what has been with some reason characterised as the "terrific energy" of the "extra current," in the same direction as the normal current, which occurs during the variable period subsequent to the passage of the latter. In this second variable period it may, however, be assumed that the *virtual withdrawal of the magnets in the circuit, i.e.*, the change of motion due to the tendency of the molecules to move in every direction, is much more sudden than the corresponding *insertion of magnets in the circuit, i.e.*, the change of motion due to the action of an E.M.F. upon the conductor during the first variable period. It may be suggested that in the second period, when the external E.M.F. is withdrawn, the discharge of molecules may be effected by rotation in various planes; and this suggestion is susceptible of being confirmed or disproved by experimental observation, since, in the case supposed, the magnetic effect of the extra current—its action upon a galvanometer needle—would be less than that which would correspond with the quantity of electricity passing.

There is so much more for me to learn than to teach in relation to the questions I have touched upon, that my main object will be fulfilled if these questions receive from others the amount of consideration that may confirm or disprove the views—which are no more than possible glimpses of the truth—which I have ventured to put forward.

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* Faraday as a discoverer. By John Tyndall, F.R.S.

* In the diagram the external + and − signs represent the charge induced in external conductors.

AMERICAN TELEPHONE PATENTS.

WHAT purports to be a synopsis of the United States Government Bill against the Bell Telephone Company and Alexander Graham Bell, appeared in the *Washington Post* of the 18th inst. The matter is referred to in our Correspondence columns by Major Barney, who does not credit the authenticity of the document. The newspaper mentioned states that the Bill was to be filed at Columbus on the 15th inst., and that the Circuit Court in which it would be filed, and the local company against which the suit would be brought, were not yet decided upon. The preamble of the Bill sets forth that the suit is brought at the direction of Solicitor-General Goode, the Attorney-General being under disability to prosecute. The suit is brought under Section 8, Article 1, of the Constitution and the Acts of Congress passed thereunder, by which the United States is authorised and empowered under certain conditions to restrain all persons within its jurisdiction from exercising their natural rights to employ their industry, ingenuity and means in making, vending, operating, or using certain arts, machines, manufactures, or compositions of matter. The Bill explains that it is the duty of the applicant for any such patented monopoly to make known fully, fairly, and in good faith, to the proper officers of the United States, all matters within his knowledge relating to such invention or discovery, or in its connection with the history or state of the art to which such alleged invention or discovery belongs. When the applicant fails to do this it is within the power, as well as within the duty of the United States, to take such action or proceedings as may be convenient and necessary to cause the facts to be brought to a fair, impartial, and judicial investigation and determination. In performance of this duty the United States charges that certain Letters Patent issued to Alexander Graham Bell, dated March 7th, 1876, numbered 174,465, and January 30th, 1877, numbered 186,788, were illegally and improperly procured to be issued, and for this reason brings this Bill in equity as a means of causing justice to be done. It is claimed that Prof. Bell, although up to time of the issuing of his patent he had never been able to transmit articulate speech by the method or with the apparatus described in his application, purposely framed his application and claim in ambiguous and general terms, in order to cover both antecedent and future inventions, and to deceive and mislead the examiners of the Patent Office and the public. Prof. Bell is plainly charged with not only failing to meet the requirements of the law, but with misleading and deceiving the examining officials of the Patent Office. By carefully refraining from any reference to the transmission of articulate speech by electricity, he caused these officers not to make any inquiry as to the state of that art or the patent or the printed publications concerning it; wherefore the United States avers that the patent issued upon such delusive and ambiguous application was and is void, and of no effect. The case of Prof. Elisha Gray is entered upon at length, and it is charged that the wording of Prof. Gray's caveat became known to Bell through the examining officers of the Patent Office, and that by reason of collusion between the examiner Wilbur, Prof. Bell, and his attorneys, Gray was induced to abandon his caveat. Attention is also called to the fact that Bell claims to be the original and first discoverer or inventor of what is called the undulatory current of electricity, whereas that current was described by Faraday and other writers on electrical science, and that the combination of the magnet and the closed circuit, which Bell also claimed to be original with him, were used in the inducting telegraphs of Gauss, Weber, and Siemens. Under the head of "prior use, knowledge, and publication," the United States charges that Bell was anticipated in the discovery of the electrical speaking telephone by Philip Reis, Cromwell Fleetwood Varley, Antonio Muecci, Elisha Gray, Thomas A. Edison, Asabel K. Eaton, and many others, and it is claimed that this valuable discovery is either the property of some one of these prior discoverers, or, having been abandoned by the first and original discoverer or inventor to the public, is now free to be used by all the people of the United States. The Bill then takes up the patent of January 30th, 1877, and it is claimed that when Bell applied for it he well knew that every material part, portion, and device and apparatus set forth and described therein was not his invention. It is further claimed that this patent was obtained by fraud upon Amos E. Dolbear, professor of physics at Tuft's College in Massachusetts. Dolbear, it is alleged, discovered and invented the magneto-telephone now used as a receiver by the American Bell Telephone Company, but that, in order to obtain a patent for his invention, he communicated his design to a friend, Percival D. Richards, who, being a friend of Bell's, communicated Dolbear's invention to him, and the patent of January, 1877, was the result. It is stated that the Dowd case was a collusive one, brought to deceive the public and sustain the monopoly by an apparently legal decision. It is stated to the Court that only the Government, and not a private citizen, can bring suit to repeal the patents granted to Bell, and the Court is therefore prayed to decree that the two supposed patents described "be in all things recalled, repealed, and decreed absolutely null, and that the record thereof, and of each of them, as the same exists and remains in the Patent Office of the United States, or in any of the archives of the United States, be in all things expunged, erased, and obliterated, and that your orator and all the people of the United States be in all things restored and reinstated as near as may be to the actual condition and state existing prior to the inception and execution of the said scheme of the said Bell to unjustly obtain the issue and delivery to him of said wrongfully obtained letters patent." The Court is prayed also that if the patents are not to be wholly repealed the Court shall decide in what part they are void, and make a decree covering that portion of the patent which is wrong and illegal.

MILL LIGHTING BY ELECTRICITY.

AN extensive addition to the electric lighting system at the mills of Messrs. S. C. Lister & Co., Manningham, Bradford, is in course of completion. It is four years since electric lighting was first introduced at these mills, and since that time several prolonged experiments have been carried out, and small alterations made from time to time. The lamp which the firm has found to give the most satisfaction is the "Pilsen," manufactured by Paterson & Cooper, and it is now intended to fix 100 of that type, of 1,000 candle power each. To permit of the present extension being properly carried out, and in order to ensure the best possible arrangements for the proper maintenance of the light, it was determined that the dynamos and other apparatus should be placed together, instead of being fixed at different parts of the mills. Accordingly, a large shed, now known as the "dynamo-shed," has been set apart exclusively for the machinery and appliances connected with the light. At one end of the shed a double-cylinder "Robey" engine, capable of working up to 100 horse-power, is fixed upon a solid concrete foundation. The engine was specially built for the work it is now doing, and it is fitted with a Buss governor, double driving wheels, and other improvements calculated to ensure steadiness in running. The number of dynamos presently in use comprises four of Paterson & Cooper's Phœnix machines with 14 1,000-candle lamps on each, one Pilsen-Joel with 20 1,000-candle lamps, and one Gramme with one 3,000-candle lamp. Two more three-light Gramme machines are being got ready for use. The "Phœnix" dynamos have given great satisfaction so far. They have been run as long as 16 hours without any appreciable heating, and there is no sparking at the brushes. Each dynamo is fitted with a safety-fuse, and the wires leading from them to the switch box are very carefully laid under the floor in wooden groves. As far as possible, both in the dynamo shed and elsewhere, the negative and positive leads are kept well apart, and the risk of fire from short circuiting is reduced to a minimum. At the switch box the wires from each dynamo pass through the respective switches, and in every circuit an ammeter and regulating resistance of 1 to 5 ohms is placed. There is also a voltmeter which the attendant can switch on to any of the dynamos when necessary, and at the top of the box resistances are arranged in case it should become necessary to remove lamps from any of the circuits. Leaving the switch box, the wires run in wooden grooves under the floor and up the inside of the wall to the top of the dynamo shed, whence they radiate to the different parts of the mill on large insulators fixed to substantial wooden standards. Those departments of the mills in which the light has practically replaced gas illumination are where the manufacture and examination of velvets, plush, and imitation sealskin are carried on. In nearly all of the rooms devoted to these purposes it had formerly been impossible to work after the hour when it was necessary for the gas to be lit. Under the new system, however, the work may be carried on at any hour of the night or during the dullest days, it being quite possible to strike the nicest shades of colour or match the most delicate patterns by means of the electric light. The nature of Messrs. Lister's business very often requires night work to be performed, and they have therefore adopted electric lighting in the departments named more as a matter of necessity than from any motive of economy, although they anticipate that the new light could if necessary be worked at quite as moderate rate as gas.

To give some idea of the power of the light and the great revolution it must effect in the working of Messrs. Lister's business, what is known as the "Blue Shed," in which there are the greatest number of lamps, may be cited as an example. In this shed there are some 60 shearing machines, and for the purpose of enabling the work to be carried on at night, 14 arc lamps of 1,000 candle-power each have been erected. Under the system of gas illumination two and a half gas jets were required for each machine, or about 150 to carry on the work of the shed. Even then the process could not go on with any degree of accuracy or reliability, and in addition the great heat of the gas was almost unbearable.

The Pilsen lamps are used throughout the works, and in many cases, the more especially when they are used for the examination of goods, the light is naked, so that a greater concentration of light can be brought to bear on the delicate colours, and on flaws that might appear in the pieces, than would be obtainable with a globe. Globes are, however, used where a diffusion of light is necessary; and the same object is obtained by the use of large white shades. It may be mentioned that 12 lamps of 1,000 candle-power are presently used in connection with the erection of a new shed, so that work may be carried on at night; and the masons are said to prefer the light to the actual light of day. These outside lamps were erected and put in working order in less than two days, and we may hope that public opinion of outside lighting, which must have been severely shaken in the Bradford district by the failure which occurred in connection with the lighting of the building operations at the Saltaire Palace of Delight, will thus be re-established. The light at Manningham Mills, both under cover and in the open air, is absolutely steady, and gives great satisfaction to Messrs. Lister, who contemplate a still more extensive use of it. The installation has been carried out for Messrs. Paterson and Cooper by Mr. Thomas Preece, through their representative Mr. Wilson Woodhead, and under the personal supervision of Mr. Wm. Driver, one of the principals at the mills.

THE AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE HISTORY AND PROGRESS OF ELECTRICITY AS APPLIED TO MOTORS.

By Mr. W. J. JOHNSTON.

AFTER alluding to the work of M. Marcel Deprez, Messrs. Siemens and Halske, Prof. Fleeming Jenkin, and others, with which our readers are already familiar, Mr. JOHNSTON continued:—Thus far the electro-motor has been discussed principally in its relation to the past. This, however, is a fitting occasion to cast a glance toward the future and to consider some points which are of special interest to this Association. I refer to a general distribution of power by electricity. In considering this problem, it may be well at the outset to set at rest some misconceptions which have unfortunately gained ground, due to the unguarded statements of enthusiasts. The question of economy is a matter of great importance here. The cost per horse-power per annum when using a stationary steam engine as the prime mover is a quantity variable with the conditions of the engine and the magnitude of the power. It is evident that a plant of 100 horse-power or more can be maintained more economically per horse-power than one of 25 H.P. or less. It would take me too long to demonstrate this by actual figures, and indeed the statement is so obvious that it hardly requires special demonstration. It is evident, therefore, that with increasing powers a point is reached at and beyond which the cost of power can be maintained in an independent establishment with equal economy to that of a central station itself, but that below that point the power can be supplied more economically by electricity from a central station. It would be impossible to lay down a universal rule as to this critical point in the power, for evidently it must vary according to locality and other conditions.

While the exact limits are variable, a slight consideration makes it evident that a general power distribution must be designed, so as to meet the requirements of a large number of comparatively small motors in circuit. I need not recapitulate many attempts that have been made to supply the demand for a small motor to perform intermittent services of widely differing character. Modern civilisation has created almost as great a demand for power as for such other adjuncts of convenience or necessity as light, water and heat. The advent, within the last few years, of numerous small gas, steam, water and petroleum engines, bears witness to this.

How many small workshops there are in which a reliable power from a central station would be a boon. In how many situations would such a small motor replace costly manual labour or animal power. A little consideration of this subject cannot fail to impress any practical man with its importance, and to give rise to the hope that it will soon receive the attention it deserves. When we consider further the fact that a double copper conductor, one square inch in section, is able to transmit 250 horse-power over a moderately long distance, without appreciable loss and without danger to life, and take this in connection with the present low price of copper, we must all admit the advisability of studying the problem of power distribution with the same energy as that of the electric light.

Several attempts have already been made to utilise lighting dynamos during the daytime for the purpose of running electro-motors in the circuits.

There seems to be no good reason why most electric light stations should lie idle and unproductive during 10 hours of the day when with their spare dynamo or two to guard against accident, they could easily be converted into a power station. Reference is here made particularly to arc light stations (as they are at present in the majority) in which the wires existing are strung overhead, so that a motor in a building can be attached without any delay or interruption of service.

In order to make such a service feasible, however, the electro-motors employed, whether they be in series, as on arc circuits, or in parallel, as on incandescent lamp circuits, must be designed so as to maintain uniformity of action under the most varying external conditions. Uniform speed under all conditions of load is probably one of the principal requisites of any motor, and hence not less so of the electro-motor, and different constructors have solved the problem of securing the desideratum, by mechanical or electrical means, into a description of which it is not necessary to enter.

But while good regulation is an essential element in a successful motor, that of high efficiency is of perhaps still greater importance. While the electro-motor has been the subject of extended study, it cannot be said that any definite and generally accepted rules have as yet been laid down regarding its construction, in the same sense, at least, as for the dynamo. That considerable remains to be done in this field is evidenced by the fact that up to the present the efficiency of motors has, as a rule, been comparatively low. There seems to be no good reason, however, why the electrical efficiency of a motor should not approach that of the dynamo, within limits, and the proper proportioning of parts and the study of their interdependence can alone bring about improvement over the present state of things. The efficiency, while comparatively low in large electro-motors, is still lower in the small ones, which is particularly unfortunate, from our point of view, as it has already been shown that the small motor will constitute the principal factor in an electric power distribution. It may be set down as an axiom that a small machine rarely equals in efficiency a large one of the same type, but the difference which exists in the case of the electro-motor is in many cases out of all proportion and irreconcilable with the simple conditions involved. As has been recently pointed out in the *Electrical World*, the small electro-motor requires a thorough overhauling, and already one of our most prominent electricians has succeeded, by a series of experiments, in obtaining efficiencies in a small motor which have rarely been attained by the largest. These experiments are not yet finished, and hence are not ready for public discussion, but they will soon form the subject of general attention, as they mark a decided advance.

While recommending the utilisation of electric light stations for power distribution during the day time, I would have it borne in mind that various conditions must be observed which necessarily enter into such a problem, and in which both the engineer and electrician could be profitably consulted.

The length already attained by this paper prevents me from giving more attention here to the history of electricity as applied to motors. I have already touched upon it incidentally. The sources of information on this branch of the subject are so numerous and so well known that I have taken it for granted that electric light men are generally acquainted with the past, and that it is the present and future that is of the most practical interest and value to them.

The future of electro-motors was never so bright as at present, and when our electricians shall devote themselves to this field of applied electricity with the same zeal as they have shown in other departments, we may expect as great an advance in the solution of the power problem as has been effected by the electric light in that of illumination. The field is "white unto harvest," and only requires intelligent working.

I wish to say here that in the preparation of this report I have received valuable assistance from Mr. Wetzler, of the editorial staff of the *Electrical World*, who has devoted much thought and attention to the transmission of power. In conclusion, I trust that this paper will have some effect in drawing the attention of electric light men to this important subject, and that we shall all live to see and enjoy the full realisation of the expectation of early enthusiasts regarding the electro-motor.

At the close of the paper,

Mr. MARTIN stated that Mr. Johnston had hoped to be present himself, but was unable from ill-health, having contracted rheumatism in a blizzard and snowstorm while on his way to Chicago to attend the first meeting of the association. In fact, Mr. Johnston's attendance at the first meeting had unfortunately been the means of precluding him from attendance at the third.

Mr. A. F. UPTON said that they must all have heard with interest and profit the very able paper just presented, and he added the subjoined remarks: At the electrical convention held last August in New York City, in a paper I had the honour to read at that time, in speaking of electric lighting stations, the following remark was made: "There is one thing occurs to me I think electric light companies should take into consideration, and that is, letting of power."

At the Edison Company's station, Lawrence, Mass., a large number of Sprague motors are used which run all day. They use from half a horse-power to five horse-power each. These Sprague motors are all employed at a good profit, and it has always seemed to me that every electric light company should use their power in the day time to run small machinery. You have it in your stations; why not use it?

Since then, information on this subject has been sought in every way and from all available sources. Electric power, in many places, has for some time been sold from central stations, just as steam power is sold, and with profit to both seller and buyer. In Boston this has been done by the Daft Electric Power Company, using the Daft system, and considerations of the results here attained will suffice to show the commercial value of electric transmissions. Dynamos are run by an Armington and Sims Company's engine, at a central station, supplying electric power to about thirty motors in various parts of the city. It is sold at $150 per horse-power per year, the price at present being about the same as that for steam for small powers. It is a curious circumstance that more power is sold than the engine can supply—a paradoxical state of affairs explained by the fact that almost no set of machinery is kept running steadily, and the company supplying power gains by the stoppages. At this station they have in use two Daft dynamos of 25 horse-power each that are run by being belted direct to a 50 horse-power Armington and Sims engine. The steam is generated in a steel tubular boiler set with the Jarvis furnace, and coal screenings are used for fuel. This power is transmitted all over the city, and is used for running all kinds of machinery, including sewing machines, ventilator fans, printing presses, elevators, and other work. The demand for power far exceeds the supply, as the company have let all the capacity of their engine, and have applications for 300 horse-power more. It is the intention of this company to start a large central station to be run exclusively to let power. The present plant has been in operation over eighteen months, and the only interruption has been three hours, when other parties cut their wires by mistake. In many cases these motors have supplanted small steam engines, gas engines, and hired power. Customers claim that the power is more regular than they have ever used before even when coming from the adjoining buildings. There is in Boston one engine running 29 elevators; if every elevator was used at the same time the engine would not have over one-half the required power.

From all the information gained, the actual loss in the process of conversion of power into electricity and transmitting power from the dynamo to the receiver amounts to about 40 to 50 per cent. The manufacturers of the dynamos claim only a loss of 30 to 40 per cent., but it is a safe calculation to allow a loss of one-half. This, as has been explained, is more than made up by the excess of power that can be actually sold and paid for. Electrical transmission has the unparalleled advantage of being superior to the obstacle presented by distance. Then again, it operates its miracles in perfect silence and repose. No force appears in the wire such as appears in shafting, in pipes with compressed air or water, in endless chains or belts; and, in case of powerful currents, insulation is easy. The conductor can be bent or shifted in any way while transmitting many horse-power, provided, of course, its continuity be not interrupted. It can be carried round the sharpest corners, through the most private rooms, into places where no other transmitter of power could possibly be taken. There is nothing to burst or to give way. In short, such a method of transmission is the acme of dynamical science. At the present time steam is the foundation of electrical power. Water power is unsteady and not reliable; gas motors are of limited power. With improved steam engines, belted direct to dynamos and the Jarvis process of utilising low cost waste fuels, the cost of making power has been reduced within the past few years fully one-half.

The most important use to which the principle of electric transmission of power is at present being put, is the running of street railways. It was only a little over five years ago that the first electric railway was built in Germany, and to-day there are many in that country where their practical success has been demonstrated. In France and England they are fast becoming popular, but it seems that those in America are yet almost of an experimental nature; in this branch of electrical science at least, America, is far from foremost.

The advantages of electricity over steam for railway purposes are many and great. In the first place, the bulky locomotive is done away with, as the electro-motor can be placed either under the car or on trucks by itself; in either case great weight and room being saved. The machinery for converting the coal into the power, or rather extracting the power from the coal is not portable, but stationary, and can be placed in the most convenient spot. For transmitting the power, in many cases, no difficulty has been experienced in using one middle rail as the conductor. Sometimes it has been found that the dirt sticking to the rails and the wheels formed a sort of crust so insulating as to prevent adequate communication. From all the information I can gain on this subject, it is, my opinion, that the most practical way will be to use wires on poles. I understand this system is used in the West by the Van Depoele Company. The poles can also be made available for stringing electric wires for both incandescent and arc lighting. The future of this system is filled with possibilities. It will eventually become the motive power of all the present horse railroads. In a few years elevated electrical railroads will be as plenty as steam railroads are now, and in time it will supersede the present system of running locomotives on all railroads—and why not? It is simply a question of cost of making power. It is acknowledged by every practical engineer that the present system of making steam in locomotive boilers is expensive as well as wasteful. The evaporation of pounds of water to each pound of coal consumed to make steam in locomotive boilers does not average over three and one-half pounds of water, using the best grades of bituminous coal, while with stationary boilers set to burn coal screenings for fuel, an evaporation of nine pounds of water to one pound of fuel is made, and the reduction in cost of fuel is from one-third to one-half. It is only a question of time when all the different electric lighting stations in this country will use their engines in the daytime to make power to be sold for manufacturing purposes, the same as they sell power in the form of electric lights now. They can also furnish power to run electrical railways, elevated or surface. The economy of this system over the cost of running horses, as used now, will be over 50 per cent.

As to speed, it is impossible to give the limit which can be reached on electric railways, because those so far constructed are on streets or in localities where very rapid transit is not possible or desirable. On the very first one built, a rate of seven miles per hour was customary. On the Berlin railway, opened in 1881, the greatest speed reached was at the rate of 18 miles per hour. More was possible, but the police authorities refused to permit more than 9 miles per hour. Up to August, 1882, there had been no breakdown on this road. On the Siemens railway, at the Paris Exhibition of September, 1881, a distance of over 1,600 feet was traversed in a minute, which is at the rate of nearly 20 miles per hour. There is every probability that electric locomotives can be run faster than any steam locomotive now in use. About 10 miles an hour is the average speed that a car can be run on an electrical street railway, but I think it is possible to run at the rate of 100 miles an hour. In the near future, on elevated railways, this will no doubt be accomplished. I believe the time will come when cars will be run by electricity between Boston and New York in about two hours' time, where it now requires six hours by steam railroads. We Yankees call ourselves practical people; we believe in the success of the use of electricity for elevated and surface street railways; believing this, we propose to put it into actual practical operation. Petitions are now before the present Legislature of the State of Massachusetts for charters for over a dozen street railways, part surface and part elevated, all to be run by some system of electric motors. In Massachusetts a horse railroad can be started under the general law, but as the law stands now an electrical railway requires a special charter. A petition has been presented asking for an amendment to the General Law and allowing electrical railways to be started the same as horse railroads are started now. We believe that the cost of power, as compared with the present cost of using horses, will show an economy of over 50 per cent. In the town of Winthrop, Mass., near Boston, sufficient money has been subscribed for erecting an elevated railway on the Enos system, to be run by electricity. The station will be constructed so as to include the use of dynamos for electric lights, and the elevated railway will be utilised for stringing wires to run them. If the charter is granted, work on this railway will be started at once. The plans are all made for an electrical station three stories high, the upper stories to be used as a manufactory and power supplied from the station below—a most profitable way of utilising the power of electric light stations in the day-time.

The electric station of the future will be erected to utilise power in hundreds of ways not now thought of. Central stations should be made large enough to combine all the present methods of using electricity, with full allowances for future discoveries, for I believe electricity is in its infancy. By this strange and novel agency power will be used to do its share toward the support and advancement of the human race. We may yet know, in our time, what electricity is, for to-day we only know it is a power that shows itself by its manifestations.

Electric light and power stations will be erected in the future as large as our present cotton mills; the engines will be used in the day-time to run lines of shafting to furnish power for manufacturing purposes, over the station; power motors will transmit electricity all over our cities to run small machinery. Both arc and incandescent lights will be used. Perhaps storage may yet be a success. Electricity will be used to drive machinery, to produce ventilation, for heating purposes; the exhaust steam will also be used for heating neighbouring buildings in cold weather.

There is no need to expatiate upon the advantages to be gained from an economical method of transmitting power; the costly and persistent attempts of inventors and capitalists to get better methods are enough to prove their desirability.

Many systems have been tried and found wanting. In electricity, thanks to living inventors, we have a force into which power can be transformed, as by the wave of the magician's wand, a force which flows to any distance with the rapidity of lightning and the stillness of a ray of sunlight, and then at bidding resumes its original shape quicker than thought can follow it.

An animated discussion ensued, it being evident from the remarks made that the members were becoming keenly alive to the importance of an early investigation of the power question.

As to Lawrence, Mass., Mr. MARTIN said he had had lately a letter from the Lawrence *American*, in which it was stated that that paper was effecting an economy of not less than 40 per cent. on power cost by the use of electro-motors, besides being free from the trouble and annoyance of a steam plant of its own.

Mr. DE CAMP thought that in order to furnish the power, stations must have new equipment, the spare or reserve plant being altogether inadequate for such purpose. He stated, however, that his company in Philadelphia were now running a number of sewing machines, averaging twelve to the horse-power.

An alternative was suggested by more than one member in the use of storage batteries, should it not be desired to enlarge the plant; and

MR. MORRISON expressed from the chair his firm conviction that the storage battery would within the next twelve months do all that might be required of it in this line.

LEGAL.

United Telephone Company v. Fleming.—This was a motion on behalf of the defendant before Mr. Justice Chitty, on Saturday, that the New Telephone Company might be made a party to an action for infringement. Mr. Bousfield, appearing for the defendant, stated that the terms of the summons were for the delivery by the defendant of all carbon telephones in his possession and for an injunction against any further manufacture, use, or sale of such telephones. Two years ago Mr. Fleming sold two Butler telephones, and these he was prepared to admit were infringements of the United Telephone Company's instruments; within the last few months he had begun to open up a trade in Valve telephones, supplied to him by the New Telephone Company.

The United Company had for a long time past contended in its notices that the Valve telephone was an infringement of the Edison patent, upon which the present action was founded. The New Telephone Company had guaranteed the defendant immunity from an action for infringement, and desired to be allowed to defend the action. Since the United Company, however, had learnt that the New Telephone Company was coming in to defend any attack upon its instruments, it had declared that it did not intend to proceed with respect to the Valve instruments at the moment. The Butler transaction was an isolated one, and was admitted. The wording of the particulars in which the plaintiff company asked for an injunction was such that the defendant feared that, although no direct reference was made to the Valve telephone, when the injunction was granted, it would be held to include that instrument, and an impression would be created, to the detriment of those engaged in selling it, that it had been decided against by the Court. The New Telephone Company was represented by counsel, who expressed the willingness of the company to defend the action. Mr. Moulton, Q.C., for the United Telephone Company, said that company did not believe what the defendant said about the Butler transaction being an isolated one. It could be proved that within two weeks of the action telephones of the Butler type had been seen in defendant's shop. Mr. Bousfield stated that those were the receivers corresponding to the transmitters which were sold two years ago. Mr. Moulton said they were not proceeding against the defendant in this action in reference to any Valve telephones. After some discussion, he intimated his willingness to re-word the particulars of the summons, so that they should be confined entirely to the Butler instruments. To this course his lordship consented.

Blundell v. The Gulcher Electric Light and Power Company, Limited.—This case was heard in the Queen's Bench Division, before Lord Coleridge and a special Jury, on Wednesday. It was an action brought by the plaintiff, formerly the chairman of the company, to recover the sum of £164 18s. 2d., being fees due to him under the articles of association as a director. The defendants counter-claimed for the amount of certain calls on shares held by Mr. Blundell in the company (made after the bringing of the action), which was admitted, and the claim thus reduced to £37; and they denied that any balance was due to the plaintiff by reason of misconduct in the management of the affairs of the company. The misconduct alleged was some irregularity with reference to the allotment, and the plaintiff went into the witness-box and underwent a stringent cross-examination as to the matter, at the close of which, the jury intimated that even assuming that the defendants proved their case, as indicated by the line of the cross-examination, by means of affirmation evidence, they did not see that there had been anything approaching to such misconduct or irregularity as should disentitle Mr. Blundell to his fees. The case was then abandoned, and his Lordship gave judgment for the plaintiff for £37, with costs on the superior court scale. Mr. Self, Q.C., and Mr. Wood-Hill were counsel for the plaintiff, while Mr. French, Q.C., and Mr. Vaughan Williams appeared for the defendants.

Universal Electric Company, Limited.—The First Division of the Court of Session, Edinburgh, last Friday, on the petition of the liquidators of the Universal Electric Company, Limited, dissolved the company and exonerated the liquidators.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XIV.

HITHERTO we have merely taken a general survey of our subject, and we have endeavoured to ascertain the power required for the propulsion of tramcars, and the losses attending the transmission and the conversion of mechanical into electrical energy. Several methods of testing electro-motors by means of absorption-dynamometers were considered at some length in the earlier articles.

Constructive details concerning motors and the gearing to be employed for the transmission of motion from the motor shaft to that of the driven wheels will next occupy our attention. All modern dynamo machines can, with very little modification, be used as electro-motors, but few of the very best of these dynamos will be found suitable for the purposes of locomotion. In fact, the most efficient of modern dynamos are the least suitable for tramcar propulsion, both on account of their shape and the great weight; we are therefore justified in drawing a distinction between an efficient dynamo and an efficient motor. We are inclined to think that this distinction will grow wider with experience, and there is no doubt that particular types of machines will be developed as the outcome of evolution, just as we have various types of steam engines most suitable for either stationary purposes, locomotives or steamboats. But apart from structural details there are fundamental differences between a dynamo and a motor. In a dynamo, mechanical energy is converted into electrical energy by the movement of the wires on the armature between the field magnet poles, cutting the magnetic lines of force. By the passage of the current through these wire coils of the armature the iron core of the latter is polarised and the direction of rotation is such as if the poles of the armature were continually approaching poles of the field magnets of the *same sign*, and receding from those of *opposite sign*.

There is a magnetic repulsion in one direction which has to be overcome by mechanical power which pulls in the opposite direction; at the same time the poles of the field magnets are weakened by induction through the similar poles of the armature, which are somewhat nearer than the dissimilar poles owing to the diameter of commutation. This circumstance, however, does not interfere with the *efficiency* of the dynamo, but it involves heavy and powerful field magnets, in order to overcome these opposing effects.

With motors the case is somewhat different, since the mechanical effect is obtained more by the magnetic attraction between poles of opposite signs than by repulsion, consequently the magnetic induction between two sets of poles tends to strengthen both, and it is not necessary to use such heavy field magnets for motors as for dynamos.

The reaction in a motor is *not* the same as the reaction in a dynamo. But apart from considerations of this nature, there are more important reasons why a locomotive motor requires an entirely distinct study, and these reasons are of a purely mechanical nature.

A tramcar motor or a boat motor must be of small dimensions, and it must be of the smallest weight compatible with a reasonable efficiency. For instance, a motor may be constructed to give 80 or 90 per cent. efficiency, but it may be so heavy that 20 per cent. of its power will be wasted in propelling its own weight. In this case it would be economy to use a motor of half that weight, and which will only yield 75 per cent. in mechanical power of the electric energy supplied to it. In the case of street cars, it takes 8 foot pounds of work per minute to move one pound weight at the rate of 7 miles an hour on the level road; 16 foot pounds to propel one pound up an incline of 1 in 75, and 24 foot pounds up an incline of 1 in 37 for every pound weight carried at the same speed. It is quite possible to make a 6 H.P. motor, weighing say 800 lbs., to give 80 per cent. efficiency; this machine, on an ordinary tramcar, would absorb 11·6 H.P. per hour for its own propulsion on the level; but it will be found that an equally powerful motor of half that weight, and of less efficiency, will be preferable.

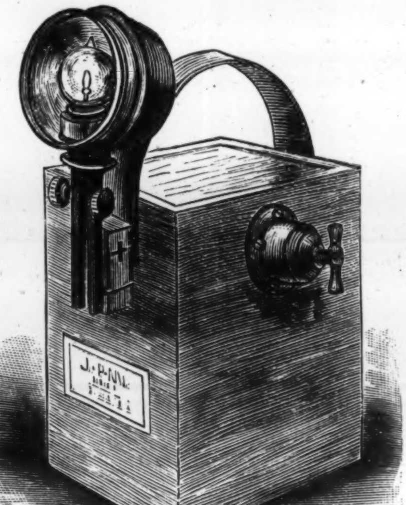
The lighter motor will also occupy less space, and this, also, is an important point, especially with electric cars, where the propelling apparatus has to be placed underneath the floor, and where it is undesirable to materially raise the body of the car. Although the floor of a car may be 26 inches above the roadway, we can only allow about 16 inches for the height of the motor with its supporting platform, so as to keep a good clearance below, and 2 or 3 inches above the machine. The length and width of the tramcar motor will depend upon the dimensions and the position occupied by the gearing used for the transmission of motion from the motor spindle to the driving axle. There is a lack of space on every side, which becomes all the more apparent when we come to consider points of convenience, such as facilities for reaching parts of the mechanism which require occasional adjustment or repairs.

Electric locomotion is becoming a distinct branch of electrical engineering, and it involves a thorough knowledge of mechanical engineering. Numerous structural details have to be worked out, and there is a large scope for those who are experienced in electrical science as well as in the principles of applied mechanics.

The problem of the speed-reducing gear will be found the most difficult, although it may appear simple at first sight, but before entering upon a discussion of the gearing we have to clear up a few more details concerning motors.

PORTABLE ELECTRIC HAND LAMP.

THE portable electric hand lamp, of which we give an illustration, is the neatest of the kind we have yet seen. The apparatus consists of a small teak box containing 3 small accumulators, with a switch at the side for turning the current on and off. An incandescence lamp placed in the focus of a highly-polished parabolic reflector provided with a glass front, is arranged as shown. A leather strap is fixed on the upper portion of the box, and serves as a handle to carry the apparatus about. The accumulators when charged will give a continuous light for 10 hours. The general make of the lamp is substantial, and there is practically nothing likely to get out of order, if the same is handled with reasonable care. The whole apparatus (which is patented) is designed and manufactured by Mr. J. Pitkin, the well-known aneroid barometer maker, of London.



A New Use for Electricity.—Mr. W. Thomson, F.R.S., uses electricity as a method of determining the relative degrees of stiffness of flour or of starch, pastes, or jelly. The method he proposes (after making many experiments) is to allow a spindle of iron 10 inches long to fall a distance of 12 inches into the paste, and then to measure with a rule the distance to which the spindle penetrated the paste. The spindle was supported by being attached to an electro-magnet, and when it hung from the magnet quite steadily the current of electricity was broken, the magnet lost its magnetism, and the spindle fell. By this means exactly the same momentum can be given to the spindle on its arrival at the surface of the paste; and, considering the nature of starch pastes, the results obtained were satisfactory.

NOTES.

Opening of the National Gallery after Nightfall.—A Parliamentary return just issued gives the opinions of the trustees and director of the National Gallery upon the question of keeping open that institution after nightfall. Those opinions are adverse, and one of the objections relates to the lighting of the gallery, the document stating that "of the several known means of artificial lighting only two are practicable in public buildings—gas and electricity. The objections to the use of the former in picture galleries are too manifest to be disputed. As to electric lighting, the science of which is in its infancy, proof is as yet wanting that it contains no elements or involves no conditions likely to affect such sensitive works of art as pictures; nor, even could it be shown to be harmless in that respect, has it been brought so fully under control as to afford security against all danger of fire on the one hand, or of sudden extinction on the other. Were the light to collapse (an event of common occurrence) much panic and disorder might ensue, with risk of accidental or even wilful injury, before the rooms could be cleared." There is absolutely no ground for the very ridiculous statements in this document with regard to the electric light. It is not a fact that no proof exists as to its harmless effect upon pictures; it is untrue that it cannot be so controlled as to avoid the danger of fire or sudden extinction; and the statement is utterly false that a collapse is an event of common occurrence.

Ship Lighting.—On Friday last Messrs. Napier, Shanks and Bell, Yoker, Glasgow, launched a handsome steel promenade-decked paddle steamer named the *Ozone*, built for the Bay Excursion Company of Melbourne, and specially designed for passenger service on Hobson's Bay. Her general arrangements resemble those of the best Clyde passenger steamers, with special modifications and improvements to suit the intended traffic. The vessel throughout will be fitted with the electric light.

On Saturday the Barrow Shipbuilding Company launched the twin torpedo cruiser *Fearless*, of the Scout class, built for the Admiralty. The torpedo armament will consist of eleven torpedo tubes or air guns. Electric search lights and other modern improvements are to be supplied.

The other day there was launched from their Leven Shipyard by Messrs. William Denny and Brothers a steel screw steamer of about 5,200 tons gross, named the *Jumna*. This steamer has been built for the eastern trade, and the electric light will be fitted throughout by the builders themselves, and will be provided not merely for the passengers' accommodation, but also for the machinery departments and the officers and crew.

Some time ago, the London and Edinburgh Shipping Company issued specifications for the lighting by electricity of its steamer *Malvina*, and the estimates submitted by Henry Bennett & Co., Glasgow, were accepted. The installation consists of an "Andrew's" patent dynamo 68 20-C.P. lamps, and one of Tangye's "Soho" engines. The lighting has been divided into four circuits, controlling respectively the saloon, second cabin, engine-room, and holds. The steamer has been fitted throughout on the "single wire system," and the result has proved highly satisfactory. Messrs. Bennett, we believe, have several other important contracts on hand.

Hotel Lighting Abroad.—The Windsor Hotel, New York, is now beautifully lighted by a 500-light installation, on the Westinghouse system. The vestibules are illuminated by single lamps of 150 candle-power each.

Lighting Literature.—*Modern Light*, a journal devoted to coal gas and petroleum interests, electric lighting and kindred methods of illumination, made its first appearance in January at Boston U.S.A.

The Lighting of the Theatre Francais.—A Paris correspondent writes: The electric light is going to be tried at the Théâtre Français, in the hope that it may be permanently used instead of gas. Should it succeed, the expectation is that the summer and early autumn seasons will be more profitable to the company than they hitherto have been. A gas-lighted theatre is an oven in summer, and at all times of the year the inner heat causes such rushes of cold air from without whenever a door is opened that playgoers who have not throats and lungs able to resist any sudden change of temperature risk their lives.

Electric Lighting in Vienna.—*Gas and Water* says: "The electric light has received a severe check in Vienna. A great many arrangements between the electricians and the Town Council were cut and dry; but the higher authorities have intervened, and direct that, since the electric light is in nothing more than an experimental stage, and since it is neither the duty nor within the competence of the town authorities to risk the public money in encouraging the electric light, the arrangements in question shall go no further. Private consumers may, as they please, make their own bargains with the electricians."

Electric Lighting in Rouen.—Electric lighting is to be charged at Rouen, according to the proposed scheme there, at the following rates:—A group of three lamps of 54 candles each, 3d. per hour; a group of four lamps of 45 candles each, 2½d. per hour; a group of five lamps of 13½ candles each, 2d. per hour; not less than 1,000 hours per annum to be charged. A prime charge of £6 for fitting up and renewals of one group. There are some anomalies in this scheme, remarks *Gas and Water*; the second mode of grouping is, for instance, decidedly the cheapest—too cheap, one would say, to be remunerative, for electric light, that is to say.

Maxim-Weston Electric Company.—The secretary writes as follows:—"This company has just received a most satisfactory report regarding their latest foreign installation, which includes the lighting of the entire surface works of one of the largest mining companies in South America. The manager of the company in question has written regarding the light as follows:—'I am pleased to report that your two electrical installations have so far given the greatest satisfaction. Since starting a month ago we have run these all night without the slightest hitch, and the light has effected a great saving by preventing theft, it being possible for one watchman to see what is going on at the furthest extremity of the mill. The wiring of one of the shafts will be complete in a week or two, and I have no doubt will prove equally successful.'" The secretary states that the company has received several large home and foreign orders during the present month, and that they hope to be in possession of and in full operation at the new works they have taken by the end of next month.

Navigation by Electric Light.—Lloyd's sub-agent at Ismailia, under date March 23rd, 9.50 a.m., telegraphs that the *Carthage*, lighted by electricity, left Port Said on the 22nd at 8 p.m. and arrived at Ismailia at 5 a.m., the trip being very successful.

Fatal Fall from an Electric Light Tower.—An accident in Detroit proved the aptness of the statement made before the Electric Light Convention by Mr. C. J. H. Woodbury, to the effect that a "lineman is in infinitely greater danger from gravity than from electricity." One of the trimmers fell from the top of a Detroit electric light tower, the fall of 140 feet killing him instantly.

The Telegraph in Asia.—The *Times* correspondent, at Tientsin, telegraphed, on February 27th, that: "There is a report (which needs confirmation) that an arrangement has been made between the Governments of China and Russia to connect Pekin and Kiakhta by telegraph."

Registered Telegraphic Addresses.—In answer to Mr. D. Smith, in the House of Commons, on Tuesday, Mr. H. Fowler said: There are, the Postmaster-General tells me, several objections to the official publication of a list of registered telegraphic addresses, the chief among them being that inconvenience to the public would arise from messages being addressed to names which, although appearing in a periodical list, had ceased to be registered. Numerous alterations, I should explain, take place in the register every day, some names being altered and others withdrawn. I may add that certain persons strongly object to the publication of their registered addresses.

Amongst the notices of questions for Thursday evening, in the House of Commons, were the following:—By Mr. Seton-Karr: Whether the Post-office authorities can adopt some means to prevent the payment of fees for valueless and inoperative abbreviated telegraphic addresses. By Mr. Labouchere: As to the expediency of reducing the fee now charged for registered telegraphic addresses in provincial towns to one-half.

Telephonic.—The National Telephone Company has rented almost the whole of the underflats of the Royal Exchange, Glasgow, for its telephone exchange.

The Telephone as a Fire Alarm.—Another instance of the value of the telephone is to be noted in connection with the recent alarming fire at Lemberg. The fire originated at five o'clock in the morning, and immediately on its discovery the alarm was telephoned to the fire brigade, who arrived on the spot in time to save the building. The advantages of the telephone system were so apparent that the Mayor of the town directed the superintendent of the exchange to call upon him with the view to its extension. This exchange, as well as many others throughout Austria, is worked by the Telephone Company of Austria, Limited, a subsidiary of the Consolidated Telephone Construction and Maintenance Company.

A Direct Wire to Australia.—Sir T. M'Ilwraith has been expressing his astonishment that the Queensland Legislative Assembly should tolerate a "monstrous" charge of 10s. 10d. a word exacted by the telegraph companies, with the permission of the Telegraph Conference at Berlin. To overcome the monopoly he advocates the construction of a direct line from Australia to England, all the colonies combining to carry it out.

Cremating by Electricity.—In these days of enterprise and innovation it does not do to be surprised at anything new; but the following scheme is somewhat uncanny and blood-curdling. It is proposed to adapt electricity to an entirely new use, namely, to cremation. At present details are scanty, and, while cremation by fire is not allowed, it is perhaps early in the day to talk of employing electricity for that purpose. The process is as follows:—The body being shrouded in sheets made of asbestos, is laid upon a frame composed of fire-brick, while at the head and foot are large copper plates, to which the leads from specially-constructed dynamos of large electromotive force are attached. The body apparently occupies the position of the filament in an incandescent lamp, and, upon the current being passed through it, would be instantly carbonised; while, as the air would have free access to it, the process of destruction, or rather decomposition, would be immediate. This process appears to have the recommendation of great rapidity of action, and freedom from many of the objections to cremation in the ordinary way, and admits of several little improvements upon all recognised forms of burial; it might be so arranged that the next of kin or the chief mourner should with his own hand press the knob sending the current through the body, and thus have the melancholy satisfaction of performing the last sad rites. We do not know the inventor's name.

The Telephone and Rifle Shooting.—Some experiments have recently been made near Portsmouth with the view of ascertaining the utility of establishing telephonic communication with the "markers" at rifle shooting matches. The trials which have been made at Browndown appear to have been of such a highly satisfactory character, that it is probable that the system will be generally introduced at the targets there. The *modus operandi* is as follows :—Wires are laid on posts at a distance of about four feet from the ground, and extend along the ranges from end to end. These would be of a permanent nature, but the telephones are extremely small, and are of very much the same pattern as those used on board Her Majesty's ships for diving purposes. The operators wear a kind of elastic cap, to which are affixed the telephones ; and, of course, this apparatus can be attached or detached at pleasure. The "marker" behind the butts, and the officer in charge of the firing party, might thus be in direct communication with each other, and to the latter might be communicated almost instantaneously the result of each shot, while the "marker" could receive his directions without the least trouble.

The Watt and the Joule Practical Electric Units.—Mr. Desmond FitzGerald writes to the *Engineer* to correct an error of terminology in Mr. Kapp's article on "Testing the Commercial Efficiency of Dynamo Machines." Mr. Kapp says, since the unit of current is 10 ampères, and the unit of electromotive force 10^{-8} volts, and since the product of the two must be equal to the erg, we find that one watt equals 10^7 ergs. Mr. FitzGerald says : Now, the product of 10 ampères into 10^{-8} volt is correctly $\frac{\text{1 erg}}{\text{time in seconds,}}$ or one absolute electro-magnetic unit of power on the C.G.S. system—a unit which has not received a name. The volt-ampère or watt, which is the practical electric unit of power, or $\frac{\text{work}}{\text{time}}$ is, therefore, $\frac{10^7 \text{ ergs}}{\text{time in seconds.}}$ It is the volt-ampère second, or joule, *i.e.*, the practical electric unit of work, which is equal to 10^7 ergs. Electrical work is very commonly expressed in watt-hours, and thus the joule or $\frac{\text{watt hour}}{3600}$ is a unit not often used. The distinction between power and work is so often lost sight of that the present correction may be of value to some of your electrical readers.

Drop-Forged Copper.—Mr. C. E. Billings, of Billings and Spencer Co., of Hartford, Conn., after a great deal of patient experimentation has succeeded, says the *Scientific American*, in producing drop-forgings in copper. Pure copper connectors, screws, and other parts of electrical apparatus have hitherto been unobtainable, owing to the difficulties experienced in casting copper. It has been the practice to add to the copper a small proportion of tin to insure a homogeneous and smooth casting, but the tin interferes with the conductivity of the metal; its presence is therefore undesirable. Mr. Billings's efforts will be appreciated by manufacturers and users of electrical apparatus.

Galvanic and Magnetic Appliances.—A correspondent writes :—"Is magnetism, as represented by Mr. Lamont's appliances, as compared with electricity in the form used in the 'Pall Mall Electric Association's' Electropathic Belts—and more especially their Medical Battery Belts—the quicker curative agent in nervous debility and other nervous disorders." Our editorial sufferings have not yet led us to experiment with any of the apparatus above-mentioned, but we are of the opinion that, "kill or cure," the galvanic appliances would be the more efficacious.

Secondary Batteries as Regulators.—We have received a communication from Mr. R. Percy Sellon on this subject, too late, however, for insertion in our present issue.

To be Let. — We noticed the following in the *Standard* this week :—

"Colchester (near to) ; only 1¼ hour's train from London.—To be let, Berechurch Hall, a handsomely furnished modern mansion, containing about 30 bed and dressing rooms, fine reception rooms, spacious offices, and extensive stabling, all lit by electricity ; with capital shooting over the manor of about 3,250 acres.—Apply to Messrs. Daniel Smith, Son, and Oakley, land agents and surveyors, 10, Waterloo Place, Pall Mall, S.W."

Our readers may probably call to mind the letters of Mr. Octavius Coope which were published from time to time in the columns of our leading "daily," on the lighting of Berechurch Hall.

The Edinburgh Exhibition.—The members of the Edinburgh Architectural Association paid a visit on Saturday afternoon to the exhibition buildings on the West Meadows. Mr. W. A. Bryson, Edinburgh, explained the system of electric lighting. In the main avenue, he mentioned, there would be 1,444 incandescent lamps of 20 candle-power each. The permanent building will be lighted with 150 arc lamps, and in front of the main entrance there will be other six arc lamps. On the northern promenade there will be 32 arc lamps, each of 2,000 candle-power, and suspended from eight masts 50 feet in height. The ornamental lighting will be obtained from 1,200 incandescent lamps coloured red, blue, and yellow, each of 10 candle-power, and these lights will be festooned in rows from Venetian masts. Old Edinburgh will be illuminated by 250 incandescent lamps ; and in the machinery section there will be 32 arc lamps of 2,000 candle-power each. Incandescent lamps will be fitted round the band stands and refreshment rooms ; and the lighting of the whole of the buildings and grounds will be effected instantaneously.

Electric Locomotion.—The article which we publish this week from the pen of Mr. Reckenzaun opens up what might be an important discussion as to why a motor should be *different* from a dynamo ; lately a good deal has been said to show that the two machines should be identical. The opponents of the latter theory might reasonably be expected to say that centrifugal pumps and turbines are *identical.*

Improved Battery Cells.—We have received from Messrs. Gent & Co. one of their new patent insulated Leclanché cells, in which, they claim, the battery salts are prevented from creeping. Lead tops to the carbons are done away with, the terminals being embedded in the carbon itself. We shall hope to give an illustration of the new cell in our next.

The Reviewer and the Reviewed.—Professor Silvanus Thompson's latest edition of "Dynamo Electric Machinery," has recently been reviewed in the columns of a contemporary. Some correspondence has taken place between the Professor and the Reviewer, and the former last week clinched his arguments by the following hostile paragraph :—"If he will ask me to show him how the curved sole of my boot can be placed approximately parallel to the horizontal plane, I shall be happy to oblige him." We opine that if the Reviewer be the man we suspect, such conduct on the part of the Professor would result in the latter suddenly assuming a horizontal position with relation to the earth's surface, and with a velocity far exceeding that due to the accelerating effect of gravity.

Electricity is "Life."—A professor in a college asked a student one day what electricity was. The student hesitated, and tried to think of the correct answer, but in vain ; it was no use. He could not recall it, but in self-defence said, "I did know, but have forgotten." The professor replied, "This is terrible. The only man who ever knew what electricity was has forgotten !"

Photography by Lightning.—Mr. Albert S. Barker, of Philadelphia, has succeeded in taking two very fair photographic negatives of outside objects by utilising the light furnished by a flash of lightning. Mr. Barker developed the plates the same evening. From their behaviour he estimated the actinic effect of the light was equal to that obtained from an exposure of about 1-300th part of a second in bright sunlight. The very significant fact observed by Mr. Barker in his photographs, that the foliage taken shows unmistakable evidence of having perceptibly moved during the period of exposure, demonstrates that the lightning flash was by no means instantaneous.

Electrical Fountain. — American contemporaries state that Sir Francis Bolton has made a contract with Mr. Erastus Wiman for the sale of patents and rights of exhibition in the United States of his electrical fountain. The fountain will be one of the features of the Staten Island Amusement Company during the coming summer.

Fatal Carelessness.—As Hugh Oliver, aged 23, an employé of the Evansville, Ind., Electric Light Company, was at work replacing a screw on the arc dynamo with his right hand last month the screw slipped, and the man, in endeavouring to catch it, placed his left hand also on the dynamo. The current passed through his body, killing him instantly.

Oh, you are, you are !—For arriving at the true meaning of the above expressive exclamation we must refer our readers to a breach of promise case which appeared in the daily papers of Thursday. One of the parties specially interested therein is well known to the electrical profession.

Self-Induction.—We believe that our readers generally were much gratified in perusing the masterly paper read by Professor Hughes before the Society of Telegraph Engineers and Electricians as his inaugural address. The article which we publish this week on the same subject contains much to interest both the scientist and the general reader.

Incandescent Lamp Tests.—Messrs. Woodhouse and Rawson have once more gone into the question of the incandescent lamp tests made by the Franklin Institute. Their letter, however, is entirely misconceived, that which Mr. Tatham stated being perfectly correct. In no portion of the report of the Committee do Messrs. Woodhouse & Rawson figure as contestants, and the manner in which the committee became possessed of certain of their lamps was, as we have before insisted upon, fully and clearly set forth. We sympathise with these gentlemen, but their attack upon the Franklin Institute is entirely misdirected. The testing committee simply performed a duty which certainly did not include an enquiry into the right which a certain company had to enter another firm's lamps.

Electric Lighting by Secondary Generators.—The description of the central station lighting in the City of Tours which we place before our subscribers this week is very interesting. Although we believe that similar work is being carried on in this country not 100 miles from the West-end of London, information thereon is not easy to obtain.

The Uses of Secondary Batteries.—The letter addressed by Sir William Thomson to the Electrical Power Storage Company, a copy of which appears in our "Correspondence" column, is an important testimony to the value of secondary batteries.

Proposed New Cables.—The *Echo* states that the Agent-General for New Zealand has received several offers to lay a cable from Australia to New Zealand, along the existing route. The lowest offer is for £150,000. The intelligence has been sent to the New South Wales Government, with an inquiry as to whether they are prepared to entertain the proposal.

The Light Obtained from Incandescent Filaments.—According to *Engineering*, Mr. Bernstein finds from observation made on a number of lamps that the amount of light obtained from an incandescent lamp increases with the third power of the number of watts used; or, expressing this in a different way, the amount of light obtained from carbon at different stages of incandescence increases as the third power of the total energy radiated from the carbon. If λ is the amount of light emitted, measured in standard candles, V A the number of watts required for producing λ, then $\frac{\text{V A}^3}{\lambda} = \text{K}$, in which K has a constant value peculiar to every lamp. It is often useful to know at what candle-power a lamp will work at an expenditure of say n watts per candle, and from this formula we have $\text{V A} = n\,\lambda$, and on substituting this value for V A in the above equation, we have $\lambda = \sqrt{\frac{\text{K}}{n^3}}$. The constant K can be determined by making one single measurement at any arbitrary candle-power. The formula may also be put thus: $\text{K} = \frac{(\text{C}^2\,\text{R})^3}{\lambda}$. Within certain limits the resistance of a lamp changes very slightly, and may be considered constant. Therefore it appears that within these limits the quantity of light varies as the sixth power of the current, a fact observed by Mr. Preece and Mr. Kittler. The value of K given by Mr. Bernstein is constant only up to a certain state of incandescence, and is then subject to variations which seem to depend on the style of the lamp. At first the value of K is slightly higher, but it soon reaches a minimum, and then remains practically constant up to a candle-power largely in excess of the normal. The growing increase in the values of K at the highest incandescence may be supposed to be due to a change in the relationship between the energy and light at the highest state of incandescence of the carbon, or that losses of electric energy occur inside the lamp. In the last case the measured value of V A would be in excess of the energy radiated from the carbon, thereby producing an increase in the value of K. M. Bernstein is of opinion that such losses do occur.

Electric Guns.—Messrs. W. H. Reynolds and C. S. Seyton, of 31, Lombard Street, London, have for the inspection of those interested in such matters some specimens of double-barrelled guns and army rifles, altered to the new system of firing by electricity (Russell's patents). Very exhaustive tests, tending to show the superiority of the electric system over that of percussion, have been made in the United States, where the new method is said to be very rapidly coming into favour with sportsmen, and also with officers of the army. The advantages claimed for the system are numerous. The small battery (about 6 inches long and an inch in diameter) and its simple connections render unnecessary the complicated lock required in percussion, and its use would, it is believed, result in great economy in the production of new weapons; while the alteration of the existing small arms from percussion to electric fire is easily and inexpensively made. The change in the shell for use in the electric system, by the substitution of the igniter for the percussion cap, is made at small cost, and as the igniter is not destroyed or displaced by repeated firing, it has been found to have, practically, the life of the shell. By dispensing with the use of fulminate employed in the ordinary cap absolute safety is secured, and the risk in transporting and handling cartridges is also done away with. Perfection in the making of the present cap can only be proved by its explosion, whereas each igniter can be tested before the shell is loaded; and as the igniter can be extended any distance into the shell the powder is lighted over a larger area, the entire charge is more completely burned, and more force to the explosion secured. The mechanical force employed in pulling the trigger in existing arms is a cause of inaccuracy in aim, which by this system is wholly done away with. It is well known that the firing of the fulminate in the cap is injurious to the chamber and barrel by reason of its corrosive effect; this is wholly avoided by the use of electricity. The life of the shell is considerably lengthened by the avoidance of the strain caused by the expansive force of fulminate, and the necessity of reforming the shell for repeated use is lessened. The generator or battery is simple, solid in construction, and conveniently placed in the butt of the gun. From actual experience, as many as 15,000 ignitions have been obtained from one battery, without any change of the elements, and extreme alternations of temperature seem to have no effect on its efficiency. An average of 5,000 to 7,000 is therefore considered a safe estimate of the number of shots that can be fired from an electric gun or rifle without change of battery. The conditions of economy, perfection of fire, and safety in the use and transportation of guns and ammunition are specially called for in military weapons, and it is claimed that all these benefits have been attained in the Russell electric gun.

Lecture.—Mr. Wm. Lant Carpenter, B.A., B.Sc., delivered the fifth of the course of lectures for the people, under the auspices of the Yorkshire Union of Mechanics' Institutes, at Skipton, last week. His subject was "Electrical Energy and Its Uses." There was a large audience, and great interest was manifested in the experiments and illustrations. The lecturer explained what was meant by energy. Electrical energy was usually obtained from the energy of chemical action or from mechanical energy. The manner in which electric light is developed from mechanical energy was shown, and the lecturer detailed the advantages of that form of illumination.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Swansea Telephone Exchange Company, Limited.—The annual return of this company made up to the 19th ult. was filed on the 20th inst. The nominal capital is £5,000 in £10 shares, the whole of which have been taken up. Upon 21 shares the full amount has been called, and £9 per share upon the remaining 479 shares. The calls paid amount to £4,477 8s. 9d., leaving £43 11s. 3d. unpaid.

Chelsea Electricity Supply Company, Limited.—The annual return of this company, made up to the 16th inst., was filed on the 18th inst. The nominal capital is £100,500 divided into 20,000 shares of £5 each and 500 shares of £1 each; 150 of the £5 shares have been taken up and the full amount has been called thereon. The calls paid amount to £725, leaving £25 unpaid. Registered office, Draycott Place, Cadogan Street, S.W.

CITY NOTES, REPORTS, MEETINGS, &c.

Swan United Electric Light Company, Limited.

THE adjourned third ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Tuesday, when Mr. J. S. Forbes, chairman of the company, presided. The annual report of the directors presented to the meeting was as follows:—

The shareholders are aware that the company is engaged in litigation with the German Edison Company and with the Continental Edison Company which control the Edison patents in Austro-Hungary, Belgium, France, Russia, Spain, &c. Believing it to be for the interest of all concerned that this litigation should be brought to an end, the directors have spared no effort to arrive at some fair and equitable settlement with the Edison companies on the Continent. Negotiations have been carried on with this end in view; those with the Continental Edison Company are still in progress, but it seems as if in Germany the suits must be fought out. It will be seen on reference to the last balance sheet that the loss which had accrued up to 30th June, 1884, amounted to £2,327 7s. 9d., to which must be added, that on closing Paris factory in 1884, £1,128 14s. 8d., and by the fire at Lille, £1,094 2s. 11d. The loss during the year ending 30th of June, 1885, as shown by the profit and loss account, amounts to £6,258 9s. 7d., which added to previous loss brings the total up to 30th June, 1885, to £10,808 14s. 11d. The Lille and Cologne factories were not in working order until the spring of 1885. During the end of 1884 and the early part of 1885 the company had to purchase lamps to supply their customers. In spite of legal proceedings and most active rivalry the business of the company improved in the quarter ending 30th September, and shows a favourable balance of £3,206 0s. 5d., thus reducing the amount standing at debit of profit and loss at that date to to £7,602 14s. 6d. Heretofore the accounts have been made up to 30th June in each year, the directors propose that the financial year shall in future end on 30th September, and for that reason they now present the accounts to the shareholders for 15 months. The question of the distribution to the shareholders of the shares allocated to this company in the Edison and Swan Company has received the most careful consideration of the directors, but they find that such distribution cannot take place pending the legal difficulties before referred to.

Major Flood Page, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, remarked that in the initiation of the company great mistakes were made, too much was paid for the patents, and they entered upon a business of which they were not masters. The first duty of the Board of the Edison and Swan United Company had been to thoroughly bottom the affair, and make up their minds to carry on the business in future on a sound basis. They were able to come forward at the end of the first year and show the proprietors that instead of landing them in a heavy loss of £28,000 as in the previous year they had made a profit of £12,000; that profit they did not distribute, but carried to reserve. Exactly the same thing had occurred in this company. The accounts as they stood revealed not a very satisfactory state of things, it revealed a considerable loss on the working of the foreign business. The accounts were made out to June 30th, for, as they no doubt remembered, the meeting had been adjourned from time to time in order that they might have the opportunity of doing abroad what they had done at home, put the horses of the two companies together and get rid of the loss and cost of legal proceedings, and also to get rid of the terrible obstruction to business which was always attendant upon litigation about patents. Their efforts had not been wholly successful, and on the other hand they had not been unattended with some encouraging results. They had two combinations of people to deal with. Mr. Edison or his friends sold his patents, some to a German combination having its seat in Berlin, and some to a combination in Paris which controlled France, Italy, Austria, and some other countries. With respect to the Berlin business, they were in more active competition there with the Edison people than in any other place, and litigation was still pending. They had there, as in England, the very best advice which it was possible to get; they were advised that their patents were not infringements of Edison's, but were self-standing. Of course the other side said they were infringements and must be "injuncted," and they were in that state of litigation that they were working practically with an injunction round their necks. They were told, notwithstanding that, that they would succeed. They thought they might impress their German competitors with the wisdom of what they had done in England; but they (the Germans) sought to impose terms so exceedingly unsatisfactory that they could not accept them, and relying upon the advice of experts they had now determined to await the issue of an appeal coming on on the 27th of this month against the judgment of an inferior court, which had gone against this company, in opposition to the advice of the Patent Office. As regards the combination in Germany therefore it looked as if the suits must be fought out. With respect to the other combination, they had had several interviews in Paris and London, and although he was not in a position to say that they had come to an agreement, they were within "measurable distance" of an agreement, that was to say they might think it worth their while to accept the terms which had been suggested to them as counter-terms to their own. They did not at present feel inclined to do so, and something would turn upon the result of the appeal in Germany; but there was a very good prospect of their being able to come to an arrangement with the Paris Edison Company. Another advantage of having deferred the meeting upon two occasions was, that they were enabled to bring down the statement of accounts to the end of the year. By referring to the profit and loss account they would see that on the one side of the account the stock on July 1st was £4,187; there was a total on that side of £32,484 4s. 1d. On the opposite side they would see sales, &c., less commission and allowances, transfer fees, interest, &c., stock on June 30th, 1885, the balance being loss, £6,258 9s. 7d. At first sight that looked rather startling, and if there were not some circumstances which would make it more or less palatable it would be very serious. But it so happened that in that particular year their business was entirely disarranged by the fire at Lille, at the factory which, by the French law, they were obliged to construct for the manufacture of lamps in order to maintain their patents. Another factory had been started at Kalk, near Cologne, in Germany, on precisely the same grounds. The Lille factory had barely got to work when it was burnt down, and the whole process of manufacture stopped for a considerable time, and they then had the rent on their backs, the taxes, the establishment, for they had got the people together with great difficulty and could not discharge them, as very few understood the process of manufacture, and it would be difficult to get them together again. Their large stock of lamps was destroyed with the factory, and in order to supply their customers they had to purchase lamps from the parent company, which, although affiliated to this company, did not consider it its duty to supply them with lamps at prime cost. They made a reasonable bargain with them and sold a large number of lamps at a considerable profit. Thus there were two items against them: they had to buy the lamps at a price beyond the ordinary cost of production, and their out-turn of the balance of lamps was very greatly increased by the fire at Lille, for it took a long time to get the output up to a figure which would make it profitable. That balance, however, was not so bad as it looked, because the stock on hand on June 30th, put down at £7,000, was estimated at the price of production, but, of course, they had been produced on the assumption that they would be sold, as they would be sooner or later. It would not be politic to bring into the credit of the account the selling price of the lamps, and they brought them in at cost price as an asset, the theory being that they were worth at any rate what they cost to produce, the fact being that they would probably realise considerably more; therefore, that £7,000 represented a saleable value of nearly twice as much, and that being so the loss would disappear. He wished them to think that out—that of necessity, when they made up their accounts they must have a large stock of lamps on hand, which meant wages, rates and material, material being an expensive item. All that had been expended, and came to the debit of the account. On the other side, they did not put in the profit in profit and loss, but merely the cost of production. That would probably bring them nearly to a balance; there would be no gain, but there would be no serious loss. At June 30th, 1885, they had £360,000 of capital represented by shares fully or partially paid. There was a small profit on cancelled shares, and there were sundry credit balances. On the other side there were patent rights, £104,000—awfully in excess of what ought to have been paid, but there it was. It was very easy to be wise after these periodical manias which seized the public when they were induced to give a great deal more for patents than the patents turned out to be worth. Then the next items were, outlay on factories, plant, furniture, &c., less depreciation, £7,548. Then the shares in the Edison and Swan Company, £208,478. Sundry debtors, £7,634; stock in hand, £7,110. Loan on security, £11,000, and cash in hand and at the bank, £8,000, made £19,000; balance from profit and loss account, £6,258, and loss from previous years, £2,327, showing a loss on the business of £8,585 up to June 30th, 1885. Added to that was the loss by the fire at the Lille factory, £1,094. French insurance companies managed to wriggle out of their obligations in a wonderful manner, and in this instance this company had thought it better to compromise and lose a considerable sum rather than get into litigation with the French company. They made up their minds that it was advisable to close the Paris factory, where there was a business but no profit, and accordingly they shut it up. In fact, they had been doing abroad what they had done at home with so much benefit to the Edison and Swan Company, they got rid as rapidly as possibly, and on the best terms possible, of bad bargains. That brought the loss in working to £10,800. That was not very satisfactory, but it was subject to two qualifications. First, he had pointed out that there was a tangible profit not brought to book at all—the selling price of the lamps as distinguished from their cost price; and the other point was that they had paid several thousand pounds for learning the pitfalls of the business. One had always to pay for that, and he and his colleagues thought they had had a very good get-out of the difficulties by which they had been surrounded. In consequence of the postponement of the meeting, hoping to have something tangible to report, they had availed themselves of the opportunity to bring down a profit and loss account to the end of the year, and they had printed a supplemental account to September 30th. They had increased the stock of lamps abroad at the two factories to 117,000, and the dead value lying upon those lamps was £10,234 upon a very moderate estimate indeed. By experience they had proved that in the year they sold a very large quantity of lamps at the average rate of 3s. 8d. each. They had carried into the balance 117,000 lamps at a shadow under the cost of production; they had taken them in at half the saleable price—rather under half, at 1s. 9d. If those lamps realised 3s. 6d., they would by the end of the realisation of the lamps have wiped out the whole of the loss they had incurred from the beginning, about £11,000. The future now turned upon this: had they touched bottom yet? They had learnt a great deal; they had got the means at their fingers' ends of diminishing the cost of output, because the greater the output, the less the proportion of the cost of the lamp; and they had a trade which was growing, less rapidly than they wished, but which would develop, they believed, with much greater rapidity once they got rid of litigation. The opinion of the directors was that the business was now as bad as it could be, but that they had in hand an asset quite sufficient to wipe off the loss on the business up to that moment, and that the probabilities were strongly in favour of their being able to go on and turn a present loss into a future profit. A paragraph in the report alluded to the proposal to alter the period of their financial year, so that it would terminate in future on September 30th. The reason of this proposed change was that they were enormously interested in the Edison and Swan Company, and that company would make up its accounts to June 30th, and hold its meeting between that date and September 30th, and, perhaps, at the next meeting, though he did not know such would be the case, a dividend might be declared, in which case this company would stand in for a very large percentage of it. They could not state their position without bringing into the credit of the accounts the results of the working of the British Company. Another paragraph of the report referred to the distribution of the shares allotted to this company in the Edison and Swan Company. The directors were very anxious to be relieved of the enormous responsibility of holding those shares in trust, but there were great difficulties in the way of their distribution at present. They could not distribute them at once without involving themselves in a question of considerable gravity, and the shareholders must again be good enough to rely on the judgment of the board and its solicitors, for it was much better to let the matter stand where it was at present. He concluded by moving the adoption of the report.

Mr. F. R. Leyland, the deputy-chairman, seconded the resolution, and said that it would be in the recollection of the shareholders that at the last meeting considerable anxiety was expressed as to the unsatisfactory accounts then laid before them, and, to a great extent, in consequence of that the two retiring directors were not re-elected and two new directors were put on the board. Of those two new directors he was one, and, judging from what took place at the meeting, it was for them, in concert with the board, at once to direct their attention to the state of the accounts, and also to the possibility of making the division of the shares in the Swan-Edison Company in England. Mr. Leyland, in continuation of his remarks, recapitulated the items to which the chairman had drawn attention as causing the loss, the principal one being the fire at Lille. He said it was quite clear the business was a profitable one; but the whole thing depended upon the result of the litigation, upon whether they could maintain their patents or not. With regard to the division of the shares, he did not see how they could carry out the distribution so long as the litigation, to which reference had been made, was pending. Litigation meant damages, damages in Germany, in France, in Belgium, in Austro-Hungary; and they did not know what those damages would be. When the litigation was at an end of course they could divide the shares, but then there would come to be considered by the shareholders some questions as to the desirability of such a division. There was a question as to the different positions occupied by the fully paid shares, and those only partly paid; there would be the question whether the shares should be brought to the same level, and, if so, whether it was worth while to pay the difference between the fully paid and the partly paid in order to get the Edison and Swan shares divided.

Mr. Foster criticised some points in the accounts and the manner in which a profit on the working of the last three months had been shown, but as he was not present during the earlier part of the proceedings the Chairman explained the matter to him, whereupon he withdrew his opposition.

A Shareholder asked was the Woodhouse and Rawson business finished.

The Chairman said the case was to be heard on May 4th. It had been postponed at the request of the defendants from time to time. Mr. Woodhouse had been very ill and obliged to go abroad. This company had been ready to go on for a long time, but on one pretext and another the matter had been postponed.

The motion for the adoption of the report was then carried unanimously, and the retiring directors, Mr. J. W. Swan and Mr. C. H. Stearn, and the auditors, Messrs. Quilter, Ball & Co., were re-elected, a vote of thanks to the Chairman bringing the proceedings to a close.

Direct Spanish Telegraph Company, Limited.

THE twenty-fifth ordinary general meeting was held at the offices of the company, Leadenhall Buildings, Leadenhall Street, on Tuesday, Sir James Anderson presiding.

Mr. Ch. Gerhardi, the Manager, having read the notice convening the meeting, and the report, which appeared in the REVIEW last week, having been taken as read,

The Chairman said he found that at the last meeting he dealt with what they did at the Telegraph Conference, and he referred also to their failure to get a line through Spain from Bilbao to Carthagena, and their failure also to get a good line from Madrid to Bilbao. That had been the object of this company for a great number of years. Now, he was happy to say, the proposal had at last met with the approval of the Cabinet in Spain for the first time; and, thanks to the good offices and friendly disposition of Sir Robert Morier and Sir Clare Ford, the late and present British Ambassadors, the Cabinet had put the thing in trim, and they were now likely to get a good wire established from Madrid to Bilbao. They (the directors) thought this would be a very considerable advantage to the company in improving the traffic; but, after all, speed had a great deal to do with it. Next, they were endeavouring to obtain an office in the bourse at Barcelona, which they had many reasons for supposing would make the service more reliable, and increase the traffic. Hitherto, strange divulging of messages had taken place in Spain, which they had been unable to trace or control, notwithstanding all sorts of efforts which they had made. The divulgence of bourse messages had induced the brokers to send fewer messages than they would otherwise send, and by getting an office in the bourse they hoped to end that trouble. The next thing in favour of their getting more traffic was the improving condition of Spanish trade. In these times of depression it was very gratifying to read in the *Times* that the exports for Spain in 1885 amounted to £40,000,000 sterling, "a figure which some years ago was assumed as the total of Spanish exports and imports."

The fact was, Spanish trade seemed to be increasing. He had read somewhere that someone was coming to England to endeavour to bring about a *modus vivendi* with the Government here by which we shall enjoy the favoured nation clause commercially, which we have not hitherto enjoyed, on account of our alcoholic tariff. He believed we had always been ready to alter that as soon as they were ready to give us the same as Germany, France, and other nations. These were two hopeful signs of the company's future. Then he referred last meeting to the postponement of examining their old cable between here and Bilbao. The Eastern Company was not in a position to lend one of the smallest priced ships for that purpose. for, unfortunately, a ship had been lost. The Eastern Company had two ships coming home next month with their tanks empty, and he had proposed that one of these two ships should go into the Bay of Biscay, taking an independent engineer of the firm of Clark, Forde and Co., to pick up the cable and examine whether it was worth retaining as an asset or whether it would be cheaper to condemn it and reduce the capital. The other ship would go on to Falmouth, and would there be joined by one of Clark, Forde's partners, who would examine the cable in that part of the channel, and bring some of the cable home so that the directors might see with their own eyes and determine whether it should be retained or not. These things were being done. They still had to regret the reduction of the length of telegrams ; they did not appear to have got yet to the bottom which merchants were striving to arrive at in the reduction of the telegrams and the combination of words to mean a great deal more than they ever contemplated when codes were introduced. They failed at the last convention to get that protected or altered ; a resolution was passed by the tariff committee on two occasions, but it was rejected at full conference. Merchants had now five years during which to reduce as much as they could—and they could not blame them—and make telegrams as cheap as possible to themselves. But he was in hopes that with the reduced tariff to which they were coming, and the condensation already arrived at, they were not far off the bottom of both these things which were pulling against them. He was happy to say there was a small gleam of comfort in the fact that the traffic was improving. For the last quarter they had £500 to the good as compared with the same quarter of last year, and he saw no reason why the Spanish traffic should not be doubled; it was a ridiculous traffic for a great country like Spain, and he did not think they were anywhere near the end of their development of it. He was not inclined to take a pessimist view in this matter, and looked hopefully to the future. He moved that the report and accounts be received and adopted.

Mr. Edmund Etlinger seconded.

A Shareholder asked what would be the cost of a new cable.

The Chairman replied that they paid £60,000 for the last new cable, and he did not think they could possibly get it for less. Besides, he did not see any use for it. They had a joint purse arrangement with the Eastern Company, who had a cable to Vigo, on the same coast, and he did not think it would be wise to contemplate the laying of a new cable unless they saw their way to make it pay.

A Shareholder: Then what are we waiting for before we reduce our capital ?

The Chairman: We have an asset which represents the capital of the company. A new cable has been laid by debentures, and the old cable represents the capital. If you lose that your capital is gone. You cannot do that without an examination to satisfy the shareholders that the assets are gone, or are not worth mending. It might be that a small amount would put the cable into working order.

Mr. Hughes-Hughes: Do I understand that any payment to the preference shareholders depends on the state of this old cable?

The Chairman said very largely it must. They had no reserve to speak of at present, and their assets were not properly protected. They could not decide upon what they should do in that respect until they decided whether they would reduce the capital or not.

Mr. Hughes-Hughes: I presume that will not be done without consulting the shareholders.

The Chairman: It will be put before you in the fullest manner, and you will have every opportunity of discussing it.

Mr. Cochrane criticised some of the items of expenditure, and objected to the company paying income tax when it had no income. He suggested the formation of a committee to confer with the directors upon the subject of the constitution of the directorate. There were two Eastern Company's directors on the board, and that, in his opinion, was too large a proportion of power in the hands of that company.

The Chairman stated that income tax was paid on the average of three years, and the third year would expire next year. Mr. Cochrane had favoured them at a good many meetings with objections to the Eastern Company for having two directors on the board, but he never proposed any substantive idea which would lead to a practical result.

Mr. Cochrane: My suggestion is for the appointment of a committee to arrange with the Eastern Company to sell this company to it.

The Chairman: But the Eastern Company will not buy it.—To his mind the assets of this company never represented the capital, of which there was too much. If they could bring about any reduction, with the consent of the preference shareholders, he would be only too happy to do it.

The resolution was then put and carried.

Sir James Anderson and Mr. John Denison Pender were re-elected directors, and Mr. Robert Duke, the auditor, was reappointed, after which the meeting terminated with a vote of thanks to the chairman.

German Union Telegraph and Trust Company, Limited.

THE ordinary general meeting of this company was held at the offices, 50, Old Broad Street, on Monday, Sir James Anderson presiding.

The report of the directors stated that the total receipts during the twelve months amount to £10,930 11s. 7d., which, with a balance of £155 7s. 9d., brought forward from last account, make a total of £11,085 19s. 4d. The expenses for the same period amount to £823 12s. 3d., of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on the 20th January last, and the directors recommend the payment of a further dividend of 4s. 3d. per share, making a total distribution for the year of 10s. per share, free of income-tax, or at the rate of £5 per centum per annum (as against £5 12s. 6d. paid last year), leaving a balance of £12 7s. 1d. to be carried over to the next account. The diminished dividend in respect of the working of 1885 is attributable to the competition between the Atlantic Cable Companies, which has continued since the close of 1884, and especially so to the reduction of the tariff from 2s. to 1s. 8d. per word, which was introduced by the Commercial Cable Company. This reduction has not so far been compensated by any increase of telegraphic traffic with the United States. The loss on the Berlin Company's receipts would have been more considerable if the traffic between Germany and Great Britain had not shown a satisfactory increase. The renewal fund and reserve fund of the Berlin Company now amount to £58,000. The capital is £330,000. The cables are in good working order. The International Telegraph Conference, held in Berlin last year, has introduced reforms of great importance for European traffic. The agreement for the reduction of tariff between Great Britain and Austria and the countries beyond, which the Berlin Company accepted, has led to a satisfactory development of the traffic, and it is hoped that their receipts, by a further increase in this traffic, will not suffer any loss.

The Secretary having read the notice convening the meeting,

The Chairman stated that during the past year there had been a diminution of revenue, arising from the competition of the Atlantic Companies, and the reduction in their tariffs. The traffic between Great Britain and Germany, however, showed an increase. When they last met he expressed a hope that, at the Telegraph Conference then pending, a resolution would be passed limiting the use of code language. The matter was discussed on two occasions by the tariff committee, and a resolution was carried by a considerable majority to the effect that there should be an authorised code, using the dictionaries of eight languages. At the general conference meeting, held to confirm or re-discuss the matter, however, the motion was lost, and he regretted to find that the managers of the different telegraph companies in England were by no means unanimous as to the adoption of an authorised code or the adoption of dictionaries of the eight languages. The Post Office of the Indian authorities, and others besides, were against it, the main ground of their objection being that it would irritate their customers, the merchants. They now had five years to go on as they were, and he did not yet see the limit of the condensation system, though he supposed there was a point below which the messages could not be reduced. Happily, the use of telegraphy was growing, and therein lay the hope of the companies—in that and in the extended life of the cables. So far as the German Union was concerned, they were fairly well off, for they had a growing reserve. He concluded by moving the adoption of the report, and the payment of a dividend of 4s. 3d. per share, making 10s. for the year, or at the rate of 5 per cent. per annum.

Mr. H. G. Erichsen seconded the motion.

The Chairman, replying to questions, stated that nearly all the capital of the company was held in England, but Prince Bismarck had declined to allow it to be made an English company, and they could only remain agents for the Berlin Company. They had the right to all undirected German traffic, which was of substantial value.

The motion was carried unanimously, and a vote of thanks to the chairman and directors terminated the meeting.

National Company for the Distribution of Electricity by Secondary Generators, Limited.

THE third ordinary general meeting of this company was held, as announced in our last issue, at the offices, 18, Warwick Street, Regent Street, on Thursday last week, Mr. William D'Oyly presiding.

Mr. J. E. Pickering, the secretary, having read the notice convening the meeting,

The Chairman moved the adoption of the report and accounts, and called on Mr. J. Dixon Gibbs to second the motion, and give some account of the working of the company.

Mr. Gibbs, in seconding, said the business of the company generally was improving, and in many ways they had good promise for the future. The amount referred to in the accounts as having been received from the Banque d'Escompte for the year to February 1st last was only £1,087. That was the balance of 40,000 francs, or £1,300, due for the year. For the year ending February 1st, 1887, there would be a minimum of 100,000 francs, or £4,000. With regard to the work done, the only addition worth noticing since the report was printed was the opening of a further portion of the Tours installation. The apparatus was ready and was going out for the Italian installations, which they expected to open in the course of the next month.

Mr. Kenneth Mackenzie inquired as to an item of £4,444 in the balance sheet relating to plant and machinery.

The Chairman replied that this sum included three dynamos, two of which had been sold, the generators used in the installation on the Metropolitan Railway, the workshops, tools, &c.

Mr. Mackenzie further inquired how the valuation of the plant was made.

The Chairman stated that the cost value had been reduced and taken off.

Mr. Gibbs added that the amount shown included the plant at Turin.

Mr. Glover remarked that £360 in the profit and loss account had been written off.

Mr. Mackenzie said the preliminary expenses were shown at £486, of which £54 had been written off. Had this amount any reference to the formation of the company, and if so, why was no more than £54 written off?

The Chairman said the amount was in connection with the original formation of the company, and was a necessary expenditure. It could not all be written off in one year, and it was the proper practice to write off gradually.

The motion was then put and carried.

The Chairman moved that a dividend at the rate of 10 per cent. per annum be paid on the preferred shares.

Mr. Gustav Dufresne seconded, and the motion was agreed to.

Mr. D'Oyly and Sir James MacKenzie were re-elected directors, and the appointment of Mr. Dufresne to the board in the place of Mr. Le Fez was confirmed. Mr. J. H. Thornton, the auditor, was also re-elected.

A vote of thanks to the chairman and directors brought the proceedings to a close.

Electrical Power Storage Company, Limited.

AT the ordinary general meeting of this company, held on Thursday, Sir Daniel Cooper moved the adoption of the directors' report, which states that during the years 1884 and 1885 the directors carried out a complete change of management both at the head office and at the Millwall works, and the result has been most satisfactory, for whereas up to the period of the change there was a considerable loss in the manufacturing business, the operations of the past year show a profit, which is steadily increasing.

To within a comparatively recent period, the company has had to contend not only against the universal depression and to the slow progress of the electric light industry, but also against the want of public knowledge of and confidence in secondary batteries, caused partly by the inexperience of users as to their manipulation and treatment, and also to the many imperfect and worthless batteries put upon the market; now, however, that it has been fully proved that batteries carefully manufactured under the patents of this company, and worked in accordance with the simple instructions given, are reliable and economical, and that they are indispensable to the success of electric lighting, and other purposes, their widespread adoption is to a certainty assured.

The only gold medal awarded for improvements in secondary batteries at the International Inventions Exhibition at South Kensington, was given to this company.

Many installations, both in private houses and offices, have been carried out successfully and at remunerative prices, and are giving entire satisfaction. Accumulators are being supplied throughout England, and a considerable number have been sent to the Continent, concerning the working of which the most gratifying reports have been received.

The company's accumulators are now in use at the Society of Arts, the South Kensington Museum, Admiralty, Royal Institution, Lloyd's, Bank of England, Peninsular and Oriental Company's Offices, Bank of New South Wales, Sir William Armstrong's, the Italian Navy, &c., &c., and are being supplied for the maintenance of upwards of 1,500 lights in connection with the lighting of one of the most extensive set of offices in London, the entire installation of which is being carried out by this company.

Besides the London, Brighton & South Coast Railway and the South Eastern Railway, where the cells continue to give every satisfaction, batteries have been supplied to some other of the principal railway companies in England, and on the Continent, in connection with various systems of train lighting, and the success of this important branch of the company's business is no longer a matter of doubt.

For private house lighting the absolute necessity of accumulators is now generally recognised, and it may safely be asserted that the majority of new installations now being carried out in England include accumulators—they are also being rapidly added to such existing installations as were erected without them.

During the past season the company did a large and increasing business in temporary lighting for balls and evening parties, and fresh plant for this class of work has been prepared for the coming season. Among the installations thus carried out may be especially mentioned those for the balls given by H.R.H. the Prince of Wales and by His Grace the Duke of Westminster.

By the employment of accumulators electric launches are now thoroughly reliable, and a considerable number will doubtless be in use during the next boating season. A launch has been lately built for His Grace the Duke of Bedford, to be slung on the davits of his steam yacht, *Northumbria*, thus enabling the accumulators to be used either for the propulsion of the launch or to supply light to the ship. Wherever steamships are lit by electricity, the adoption of electric launches in this way will prove a great convenience. Among those now in course of construction, may be mentioned one for the Sultan of Turkey.

A protracted series of experiments has been carried out in connection with tramcar propulsion, and although the mechanical arrangements employed have not hitherto fully answered expectations, it has nevertheless been successfully proved that accumulators are admirably adapted for this work, and, as soon as certain minor difficulties in connection with the gearing are overcome, the electric propulsion of tramcars by accumulators will become an important industry. The accumulators and gearing of the tramcar now running at Berlin were manufactured at Millwall.

With regard to foreign work, it is encouraging to be able to state that an order is in hand for 100 tons of plates for one installation alone on the Continent, which is certainly the largest work in connection with electric lighting as yet undertaken in any country.

The directors have much pleasure in stating that the litigation in the United States, in connection with the title to some of the patents owned by the Electrical Accumulator Company of New York, is at an end, and that that company has not only ample working capital, but has been strengthened by association with some of the most prominent commercial men in the United States, while the administrative control will be in the hands of those who have already achieved a remarkable success as managers of one of the leading enterprises in that country; the directors, therefore, regard the interest in the American company, of which hitherto no valuation has been made in the balance-sheet, as a valuable asset.

The manufacture and sale of secondary batteries has been carried on at Hamburg under a license from the company for North West Germany.

A claim has been made against one of the German Faure patents belonging to this company. The case is being tried in Berlin, but the directors have confidence as to the result.

The directors have pleasure in stating that the Imperial Continental Gas Association are now the licensees of the company in Austria and Hungary.

A suit in connection with the French patents is expected shortly to come on for hearing at the Court of Appeal, in Paris, but our French counsel advise that the position both as to law and as to fact is most favourable to this company. In the meantime, arrangements for the sale of accumulators on a more extended scale are being made.

As was stated at the meeting held in July last, the shareholders of the Indian and Oriental Electrical Storage and Works Company unanimously decided that their patents and patent rights should be transferred to this company, in exchange for £15,000 fully paid up shares. The details relating to this matter are now being carried out, and it is hoped will soon be completed. The directors anticipate satisfactory business to result now that the Indian rights are under their control.

A suit was brought against Elwell-Parker, Limited, in Vice-Chancellor Bacon's Court, for the infringement of one of the Sellon patents belonging to this company. The Elwell-Parker Company, however, eventually consented, without going to trial, that judgment should be signed against them, and a satisfactory arrangement has been effected under which they have taken a license on payment of royalty under this company's patents. A reciprocal arrangement exists by which this company has the benefit of any of the Elwell-Parker patents for secondary batteries, should it ever wish to use them.

In July last the directors, with the sanction of the shareholders, took power under the articles of association to issue £25,000 7 per cent. debentures, secured by mortgage of the plant and patents in the United Kingdom. The shareholders did not subscribe to the amount of their quota, but the directors, having full confidence in the business and prospects of the company, undertook to lend £10,000 at 4 per cent., or 1 per cent. above Bank rate if higher, as and when required, the company entering into an arrangement to secure the directors by a deposit of debentures to the amount of the advance.

The directors desire to express their great regret at the loss of their colleague, Mr. William Ladd, who died last autumn.

Mr. Sellon seconded the motion, which was carried.

A fuller account of this meeting will appear next week.

Brighton Electric Light Company, Limited.

THE first general meeting of this company was held at Brighton last week. The chair was taken by Mr. Robert Hammond, who explained that this being only the statutory meeting required by the Act of Parliament, there was no report or accounts to present, but he had pleasure in stating that the agreements with the vendor had all been satisfactorily completed, and the business as a going concern taken over. Although the company was only registered on December 16th last, the business was taken over as from October 1st, and the accounts for the three months ending December 31st last showed a satisfactory profit. The directors did not, however, propose to distribute a dividend till the completion of the current year. He was glad to be able to add that the company's electric light undertaking might be considered a decided success, especially since it had been made a separate Brighton company. The light was gaining in popularity, and only that afternoon one of the leading doctors of the town had given orders for an installation in his private house, and he (the chairman) felt that a great extension of the company's business would take place as soon as it became known in Brighton that private houses could be supplied with the incandescent light at a meter rental, and paid for exactly according to the quantity consumed.

Eastern Telegraph Company, Limited.—This company announces the payment on April 14th next of a dividend of 3s. per share on the preference shares of the company, less income tax, for the quarter ending March 31st, 1886, and that an interim dividend of 2s. 6d. per share on the ordinary shares of the company, free of income tax, in respect of profits for the quarter ended December 31st, 1885, will be paid on the same day.

The River Plate Telephone and Electric Light Company, Limited.—This company notifies that coupons due April 1st next will be paid, less income tax, on and after that date, at the Alliance Bank, Limited, Bartholomew Lane, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 19th were £2,549, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited;

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 19th amounted to £3,134.

PROCEEDINGS OF SOCIETIES.

Physical Society, March 13th.

Prof. BALFOUR STEWART, President, in the Chair.

Prof. U. S. Pickering and A. C. Hayward were elected members of the society.

The following communications were read:—

"On the Growth of Filiform Silver," by Dr. J. H. GLADSTONE. It has long been known that if a piece of metallic copper be placed in a solution of nitrate of silver, replacement of one metal by the other will take place, the silver being deposited in the crystalline form, sometimes having a resemblance to fern leaves, or as superposed hexagonal plates or knobs. It was observed, however, as far back as 1872, by the late Mr. Tribe and the author, that if nitrate of silver were decomposed by suboxide of copper instead of the metal the silver presented itself in threads, which rarely, if ever, bifurcate, but frequently turn at sharp angles, or twist in every direction. This was described in the British Association report for 1872, and it was observed that the same forms occurred in native silver.

More recent observations have shown that the particular character and rapidity of formation of these threads depends very much upon the strength of the solution and the condition of the suboxide. Hydrated suboxide will scarcely decompose a two per cent. solution, even after standing. The threads, which bend at a sharp angle, usually do so at 60° or 120°; other threads, however, are symmetrically curved; but, especially in strong solutions, they are given to twisting about in every direction, and generally terminate in irregular knobs of silver. As a rule a thread continues to grow of the same thickness as it commenced, but it sometimes enlarges for a while into a flat plane, or becomes encrusted for some distance with small crystals of silver. When the solution is very nearly exhausted of silver, fine arborescent forms appear, but with the suboxide there are never produced the fern-leaved forms, or hexagonal plates, or the other distinctly crystalline structures which characterise the growth from metallic copper.

During the reaction the suboxide is changed into black protoxide and metallic copper, which dissolves; and the change will take place as well with the acetate and sulphate as the nitrate. If a mixture of suboxide and metallic copper be employed, not only do the distinctly crystalline and the filiform forms make their appearance, but strange intermediate forms come into existence.

"Apparatus for Measuring the Electrical Resistance of Liquids," by Prof. REINOLD. The apparatus consists of two bottles connected by a horizontal tube. The whole is filled with the liquid to be examined and immersed in water, by which means, and by thermometers inserted in each bottle, the temperature may be regulated and accurately ascertained. The electrodes are platinum plates, one dipping into each bottle. Two fine tubes terminate near the ends of the connecting tube, and electrodes are fitted into them at some distance from the ends; by connecting these to a quadrant electrometer or a condenser and galvanometer, the difference of potential between the ends of the tube can be compared with that at the ends of a known resistance in the same circuit.

"On Chromatic Photometry," by Capt. ABNEY and Lieut.-Col. R. FESTING. (This paper had been previously communicated to the Royal Society.) A series of experiments have been made by the authors to determine the comparative luminous effect of different parts of the spectrum. A monochromatic light from any part of the spectrum of the electric arc was obtained by a method devised by Capt. Abney, and previously described by him to the society [Physical Society, June 27th, 1885.]

The photometric effect at different parts of the spectrum was compared with that due to a candle at different distances by Rumford's photometer. In using this it was found best to place the candle in a given position, and obtain a balance by moving the slide upon which the spectrum was formed, and through a slit in which part of the light was allowed to pass, rapidly to and fro. For each position of the candle there are thus two corresponding positions of the slit. From the results of these observations a curve may be drawn showing the luminosity at different points.

From the method by which it is obtained it is evident that the curve of one observer is not directly comparable with that of another, since a deficiency of perception in any part of the spectrum would affect the light of the candle as well as that examined. Since, however, the curves obtained by a great number of persons coincide very closely with those obtained by the authors, they have felt justified in adopting them as the normal curves. In the case of the electric arc the normal curve attains a maximum rather nearer the red end of the spectrum than the blue. Assuming the normal curve, any other curve may be compared with it by increasing or decreasing its ordinates so that no part of it shall lie without the normal curve; in curves thus obtained, several of which were shown, deficiency in colour perception is often very clearly marked.

By the use of two or more slits in the movable slide, experiments were made upon mixtures of colours, and it was found in all cases that the luminous effect of a mixture of colours was the sum of the luminous effects of its components. It was also found that the colour of the comparison and the quantity of light admitted to form the spectrum were without effect upon the form of the curve. Light from the sun and from an incandescent lamp were similarly examined, though it should be observed that the result for sun light differs notably from that given by Maxwell. An examination has also been made of light after passing through a turbid medium and an expression of Lord Rayleigh's

$$\mathrm{I}^1 = \mathrm{I}\, e^{-x \lambda^{-4}}$$

where I is the original radiation, I^1 that after passing through the medium, λ the wave length of the light and x a constant depending upon the medium, has been closely verified.

Royal Society, December 10th, 1885.

"On the Magnetisation of Steel, Cast Iron, and Soft Iron," by JOHN W. GEMMELL.

In this paper the author describes and gives the results of a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of "soft Scotch iron," "common wire," "charcoal iron," and "soft steel," with bars of cast iron and malleable iron; and the object of the investigation was to find the difference between these with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force.

The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniell's, so arranged that any number of cells could readily be placed in the circuit.

The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure.

It has been found that the "charcoal iron" has the highest magnetisability, and the "soft steel" the lowest; while that of the "soft Scotch iron" approaches the former. With regard to retentiveness, the "charcoal iron" shows the least, and the "soft steel" the greatest. Annealing the latter, however, has the effect of bringing it very near the "common wire," both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus.

These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly.

In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop.

In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

Birmingham Philosophical Society, February 11th.

"ON Resistance at Surfaces of Electrodes in Electrolytic Cells," by G. GORE, LL.D., F.R.S. This paper is a purely experimental one, and contains new proofs of some of the chief results of an extensive research on "transfer resistance," communicated to the Royal Society, March 2nd, 1885) (*Proc.* Roy. Soc., 1885, No. 236, p. 209). In it the author shows conclusively that the phenomena discovered by him, and to which he applied that term, are not due to polarisation, some kind of electromotive force, or any other form of opposing difference of electric potential, because they still remain when those causes are entirely absent. He selected various cases of voltaic inversion, in which a pair of different metals in an exciting electrolyte produced no difference of electric potential and no voltaic current, and examined them for "resistance" and differences of "resistance" at the immersed surfaces of the two metals. He first tested them by a "bridge" method, and then by a "condenser" one, also described, and gives the results; and in every case he found that the "resistance" still existed, and was different in amount at the two plates. In each case the plates were of equal sizes. He also took several cases in which a pair of plates of the same metal, but of different sizes, were immersed in an exciting electrolyte, a combination which it is well known produces no difference of electric potential and no voltaic current, and tested them similarly, and found abundant evidence of "resistance," different in amount at the two plates in each instance. By the condenser method he also measured the amounts of such "resistance" at the surfaces of the two different metals, of several voltaic elements at their inversion points, during absence of difference of electric potential, and gives the quantities. He asks:—"Is the phenomenon I have discovered really of the nature of ordinary electric conduction resistance? If it is, its characters will agree with the most essential ones of that influence. It agrees in several important points with that resistance: first, it is not able to produce a current; second, it is usually small with those liquids in which ordinary resistance is small; and third, it is considerably reduced in liquids by rise of temperature, it also, when overcome by current, evolves heat" (*Proc.* Roy. Soc., 1885, No. 236, p. 209; *Phil. Mag.*, vol xxi., 1886, pp. 130—148). It differs, however, from such resistance in the less important circumstance that it varies in amount with the strength and density of the current; it is also usually much larger in amount than the ordinary conduction resistance of a short section of the same liquid. "From these various fundamental truths respecting it, 'transfer resistance' is a retarding influence essentially similar to ordinary conduction resistance, but modified, increased in amount, and rendered more complex by taking place at the surfaces of mutual contact of two heterogeneous bodies instead of in the mass of a homogeneous substance." He concludes by remarking that "it performs an important part in the action of all voltaic batteries and electrolytic cells," and calls attention to the circumstance that "one important practical application" of it "has been made in the electro-metallurgical purification of copper on the large scale, where a great saving has been effected by arranging the depositing vats in multiple series, and thus diminish the 'transfer resistance.'" It was in the year 1831 that the first attempt to discover this kind of resistance was made by Fechner.

Berlin Physical Society, December 18th, 1885.

Dr. SCHULZE-BERGE spoke on the conduction of electricity in dielectric media, a subject which had hitherto been examined in most cases only from a technical standpoint, in order to determine the insulating power of gutta percha sheathings for telegraph wires and cables. If it were assumed that the resistance of the dielectrics differed with the thickness of the layer according to the same law as prevailed in metals, then—seeing that the resistance of a cubic centimetre of gutta percha was, in accordance with Jenkin's determination, equal to 25×10^{12} ohms—the thickness of a layer, the resistance of which amounted to about 100 ohms, and ought to be measurable, must be so small as to be incapable of being produced. It might possibly be the case, however, that in dielectrics the resistance varied in another relation to the thickness, and in point of fact the speaker had found that a gutta percha layer of 1/13 mm. thickness, and a superficies of 175 square c.m. inserted between two metal plates into the circuit of a Daniell's element connected to earth, produced a very rapid discharge. Measurements executed by the speaker by means of a quadrant electrometer on thin layers of gutta percha, sulphur, paraffin, and sealing wax between two metal plates, yielded resistances very well capable of being measured, and which in the case of gutta percha amounted on an average to about 200 ohms. In the case of sulphur the values varied between 20 and 2,000 ohms, and just as varied and irregular were the resistances in the case of the two other substances. The layer offering resistance was produced by placing rubber tissue or purest flowers of sulphur on a heated plate of zinc, and thereupon pressing the second heated metal plate, after which the whole was allowed to cool. In the course of time the resistance changed. In the case of sulphur it increased, in the case of paraffin and sealing wax, however, the resistance abated; in the case of gutta percha the resistance continued pretty equal. If the cells supplying the current were disconnected, and the dielectric brought into conjunction alone with the electrometer, then the latter showed no deviation, whence it was inferred that the dielectric did not conduct electrolytically, and that it was no electrolytic polarisation which caused the change of resistance. The measurements of resistance were also taken with the aid of the Wheatstone bridge, and, after the former results had been confirmed by this method likewise, the influence of the electromotive force on the resistance of the dielectrics was determined. If the bridge system was in equilibrium, then must it remain unaltered when the intensity of the current was varied by the insertion of a changeable resistance into the circuit of the current. The experiment, however, showed that with the change in the strength of the current the needle of the galvanometer indicated a deflection. This change of resistance with the change in the strength of the current was, as the speaker had become convinced, by means also of the bridge combination, through disconnecting the chain, not caused by an electrolytic polarisation, but probably by a dielectric polarisation, which would have to be further investigated after other dielectrics, besides the four mentioned, had been tested. The most important results of his experiments were formulated by the speaker as follows:—(1) The resistance of the dielectrics varied in relation to the thickness of the layer in a different way from metals. (2) The conduction of the dielectrics was not electrolytical. (3) The resistance depended on the electromotive force.

In the discussion following this address, Dr. SCHULZE-BERGE further stated that the sensitiveness of his electrometer was so great that a Daniell gave a deflection of 120°.

Prof. SCHWALBE gave a full report of the two volumes on "Geophysik," by Herr S. Günther, published last and this year.

NEW PATENTS—1886.

3756. "Regulating apparatus for arc electric lamps." J. D. F. ANDREWS Dated March 17.

3849. "Field magnets for four pole dynamo-electric machines." P. B. ELWELL. Dated March 18.

3883. "Electrostatic induction machines for lighting gas, applicable also for other electrical purposes." W. GRIERSON. Dated March 18.

3893. "Producing electric light." H. DE CLAIRMONT, C. L. FIELD. Dated March 19.

3925. "Adjusting and regulating the brushes employed in dynamo-electric machines." R. SUGDEN, A. D. SHAW. Dated March 20.

3945. "Electrical switches." R. M. BAILY, A. GRUNDY. Dated March 20.

3946. "Method of and apparatus for transforming the conditions of electric currents." L. BOLLMANN, E. BIEDERMANN, D. MONNIER. Dated March 20.

3947. "Arc lamp." E. A. ASHCROFT. Dated March 20.

3969. "Switch and resistance regulator for dental electric motors." A. M. CLARK. (Communicated by Schafer and Montanus.) Dated March 20.

4038. "Mechanism for striking the arc and controlling the feed of carbons in electric arc lamps." C. BROWN. Dated March 23.

4057. "Voltaic piles and accumulators." P. HADDAN. (Communicated by I. Crosse.) Dated March 23.

4058. "Telegraphic recording instruments." A. M. CLARK. (Communicated by New Haven Clock Company.) Dated March 23. (*Complete.*)

4069. "Telephonic apparatus." J. E. DAUN, J. LAPP. Dated March 23. (*Complete.*)

4072. "Telegraph recording instruments." A. M. CLARK. (Communicated by New Haven Clock Company.) Dated March 23. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

1854. "An improved electric arc lamp." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. The object of this invention is an automatically regulating electric arc lamp having two pairs of carbons intended to burn one after another. The top carbons with their holders, are exactly counterbalanced by weights and chains, in order to reduce to a minimum the power required for regulating the arc and maintain the length of the arc constant, whereby irregularities in the light are prevented as far as possible. The lamp is also arranged as a differential lamp.

1856. "An improved semi-incandescent lamp." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. The object of this invention is the production of a semi-incandescent lamp, in which the carbon is surrounded by a confined quantity of air enclosed partly by the tube of the lamp and partly by a glass globe, whereby the carbon forming part of a closed circuit is caused to glow in the midst of an inert gas, chiefly azolic gas and carbonic acid, owing to which the carbon will be consumed very slowly and the light rendered uniform because the carbon will not be exposed to draught, and because the combustion takes place in a confined, and, as far as possible, constant gas mixture.

2271. "Improvements in electric current meters." J. W. SWAN. Dated February 19. 8d. The apparatus consists of a clock, a galvanometer, and a train of registering wheels; these three parts are so connected together that if a current is passing in the circuit with which the meter is coupled, a periodic locking together takes place of the index wheel of the galvanometer, one of the clock wheels, and one of the train of registering wheels. This interlocking is maintained during a length of time, varying directly with the strength of the current passing at the instant the locking action took place, and is terminated when the index wheel of the galvanometer, which is carried round by the clock train, arrives at its zero position. Whereupon an electrical contact is made which closes an auxiliary circuit and causes an electro-magnet to effect the unlocking, and the movement of the registering wheels, therefore, ceases until the next period of locking occurs.

2776. "Improvements in dynamo-electric machines, magneto-electric machines, and electric motors." W. H. ALLEN, R. WRIGHT, and G. KAPP. Dated March 2. 11d. The inventors employ an armature wound on the Gramme or Pacinotti principle and constructed as follows:—The core of the armature consists of soft iron wire or soft wrought iron discs, wound or slipped on to a supporting cylinder of brass, gun metal, cast iron or other suitable metal. This supporting cylinder is open at the ends, and its surface is provided with a number of perforations or slots, giving it the appearance of a grating bent into the shape of a cylinder.

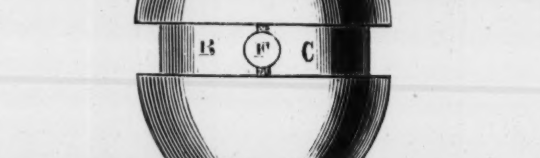
3553. "Electric relays." J. ENRIGHT. Dated March 19. 6d. The inventor brings the terminals of the circuit it is required to establish into mercury cups, and then arranges that a piece of wire shall have its ends plunged into the mercury, so as to bridge over the gap in the circuit.

3671. "Improvements in electric cartridges and electric primers therefor." S. RUSSELL. Dated March 21. 8d. Relates to cartridges to be discharged by electricity, by the heating to incandescence of a conductor of high resistance in contact with the powder.

4155. "Improvements in boxes or cells for primary and secondary voltaic batteries." C. MOSELEY. Dated April 2. 4d. The inventor constructs the cells or boxes of wood to any desired pattern or form, and within each box or cell he secures a lining of India rubber or India rubber compound vulcanised or unvulcanised.

5256. "Improvements in voltaic batteries." A. R. BENNETT. Dated April 28. 4d. With the object of increasing the constancy of the current produced by the various forms of voltaic batteries described and claimed in patents No. 302, 21st January, 1882, and No. 1901, 21st April, 1882, the inventor employs, in conjunction with the chemicals therein set forth metallic sulphides, more particularly the various sulphides of iron and copper and the joint sulphides of iron and copper. The sulphides or mixtures of sulphides and sulphur are used with the negative portion of the battery. They are mixed with the iron or other metallic borings or filings, or are made to cover or surround the negative plate of iron or other metal which need not in such a case be packed with borings, filings or other pieces of metal.

13902. "An electrical switch." G. MARRIS. Dated November 14. 6d. A, is a bulb of wood or any other suitable material, grooved and bored to receive the necessary metallic parts, B and C are metallic springs fitting into the grooves of bulb A, D is the electrical terminal of B, and E is the electrical terminal of C, F is a key plug with the thumb and finger end insulated from the contact cap at other end, the said key plug is worked by a spring in barrel G, the said barrel having a diagonal movement slot with stop shoulder; on turning the key, F, the connecting cap on F is brought into pressing contact with B and C, thus closing the electrical circuit, the reverse action of F opening said circuit, the whole enclosed in an ornamental or plain case and forming a new switch.



15078. "Improvements in apparatus for forming conduit sections for underground conductors and the like." W. P. THOMPSON. (Communicated from abroad by J. R. Burdick and D. H. Dorsett, of America.) Dated December 8. 8d. Relates to improvements in apparatus or machines for forming conduit sections more particularly adapted for underground wire service, and of that class in which the sections are composed of some suitable insulating compound or material which is moulded to form through each section from end to end thereof a desirable number of straight bores serving as ducts or passages for the conductors, the sections being usually made cylindric with their ends adapted for coupling in order that, when laid underground or elsewhere, they can be connected together so as to provide a conduit having throughout a series of separate and distinct wire-receiving passages. The material which has been found best adapted for forming these conduit sections has been filled into the mould while in a heated, plastic condition, the cores for forming the ducts being introduced into the mould preparatory to the filling in of the plastic material or composition to be moulded.

15539. "Improvements in telephone transmitters." C. E. ALLEN. Dated December 18. 8d. Relates to improvements on the apparatus described in patent No. 6689, dated June 2nd, 1885.

CORRESPONDENCE.

Franklin Institute Tests on Incandescent Lamps.

With reference to Mr. Tatham's letter in reply to ours on the above tests, we are sorry that we did not see Mr. Wahl's letter in the New York *Electrical Review* of June 20th, which, however, we consider a somewhat weak denial, in face of the strong assertions made by the *Electrical Review*.

Mr. Tatham states in his letter:—"In the conduct of the tests the cardinal principle was to do right, and also to *avoid all appearance* (the italics are our own) of wrong doing. To this end a code was adopted and judges selected with the full concurrence of the contestants, and nothing was concealed from the parties in interest. The contestants were invited to inspect, and did inspect, every step in the progress of the tests, and their experts compared the photometric measuring powers of the judges with their own."

We are surprised at the Franklin Institute again making the above assertions. We beg most emphatically to deny that a code was adopted or judges selected with our concurrence. We deny that we were ever informed of what was in progress, and we were never invited to inspect, nor did we inspect any steps in the progress of the tests, nor had we experts to compare their photometric powers with that of the judges; but, on the contrary, never heard a word of our lamps being tested until we saw in the London ELECTRICAL REVIEW that the tests were practically over. Mr. Tatham is incorrect when he says the "boast of our lamps is that they are brilliant and cheap." To advocate them on account of their brilliancy would be manifestly absurd; and, so far as cheapness goes, although our lamps are the same price to the general public as those of other makers, the trade are willing to pay, and do pay, a higher price for them than any other lamps. What we claim is that the efficiency of our lamps will be found considerably greater than that of other makers, while the life of our lamps compares very favourably with them.

With regard to the method adopted by the committee of running our lamps 5 volts higher than they were marked, we think that some statement should have been made of the fact that for some considerable time the lamps were run at from 25 to 32 C.P., or an efficiency of about 2¼ watts per candle-power (mean horizontal intensity), and yet in their report the committee use the words "possibly received more than their proper E.M.F." In the face of the above, these words present a needlessly incorrect view of the case.

With regard to Mr. Preece's statements, he had ample opportunity of testing the lamps at the Wimbledon trials, where they were run for some considerable time, our lamps being we believe the only ones of which none broke the whole time. As for the statement that some of the lamps were sent over by Mr. Preece specially to be tested by the Franklin Institute, the following is Mr. Preece's reply to our letters :—

"Gentlemen,—The lamps tested at Philadelphia appear to have been some of yours sent by me to a personal friend, who omitted to give me the faintest idea of the purpose for which they were intended. Had he done so I should of course have told you. I had the pleasure of inspecting an installation recently where your 20-candle lamps have obtained an average life of 1,500 hours, and many of them are now 'alive and kicking' after 4,000 hours work. They were 80 volt lamps running at 79 and taking ·73 ampères or 56·7 watts each. "Yours faithfully,

"(Signed) W. H. PREECE."

As we have every confidence in our lamps, we are only too anxious to have them tested in competition with those of other makers, and we shall be happy to subscribe £50 towards any tests such as mentioned lately by Mr. Crompton.

Woodhouse & Rawson.

Secondary Batteries as Regulators.

I hesitate to address you again this week, but your editorial remarks call for explanation. It is perfectly true that for a continued fall of speed, in the case of a dynamo, the E.M.F. falls, but if, with a shunt, the "falls" are sudden and spasmodic (say driven by a gas engine and tight belt) I found sudden rises of E.M.F. corresponding to the falls in the speed, as if the shunt coils acted somewhat as an induction coil. It may have been a special case, but it appears not unlikely to be the rule if the curve of the machine drops rapidly.

I notice a printer's error in line 4 from the bottom of my last week's letter, which alters the meaning completely. Read "corrected" for "connected."

I fear you are rather misled as to my meaning of "a good dynamo electrically." By this is understood a machine (shunt) giving a curve which shall be almost a straight line ; in other words, the armature shall have a resistance approaching zero as near as possible, and, of course, otherwise well designed, for the falling curve indicates appreciable resistance in the armature, showing avoidable waste.

You say makers of dynamos consider that a machine with a very drooping curve is most suitable for charging cells. I believe that I was the first to point this out in the paper I wrote on "Constant Electromotive Force, &c.," and it is perfectly true that good regulation may thus be attained, and the paper showed at the same time that other dynamos failed in this respect. In the discussion which ensued Mr. Crompton and others condemned such dynamos as wasteful, and declared them machines of the past. In replying I agreed, except for small installations, which were then under consideration. In short, to work cells properly to secure good regulation, a dynamo with a curve of much fall should be used ; in other words, a machine with an armature having considerable resistance, and therefore wasteful. On the other hand, if a good machine were employed, with a nearly straight line for its curve, so that the E.M.F. is practically constant for all currents given off to the limit of its power, it will give no regulation whatever, except by the law of shunt currents. In large installations these latter dynamos only can be used.

One word on the question of the *s.g.* of the acid in a cell and its E.M.F. as indicating the state of charge. The voltmeter is unquestionably the best test, but it is variable because the cells will not always give the same E.M.F. when they have been long in use. Again, when the cells approach the end of the charge, the E.M.F. rises but very slightly and it is not easy to detect the variation. The hydrometer has many faults ; but two virtues it possesses, one is that it rises during the charge, and, secondly, a time arrives when it rises no more, or, at any rate, one or two hours' charging does not appreciably affect it. Thus the "fully charged" problem may be solved, especially if two Ferranti meters are employed, by comparing three things :—

1. Charge till the E.M.F. indicates no more rise.
2. Observe if the hydrometer also ceases to rise appreciably.
3. See if the meters indicate that the ampère hours put in exceed somewhat those taken out.

The "boiling" test might be added, but this does not always take place when it should do ; much overcharging is often required to produce this result.

David Salomons.

Broomhill, Tunbridge Wells.

A Testimony to Secondary Batteries.

Prof. Sir William Thomson, F.R.S., writing from the University, Glasgow, has kindly forwarded for publication the following copy of a letter addressed by him to Mr. Bernard Drake, the Engineer to the Electrical Power Storage Company :—

(COPY.)

Dear Mr. Drake,—Your storage cells have given me the greatest satisfaction. I have used 44 of them for my house lighting ever since I got them first charged up, within a few days after receiving them from you (November, 1885), and they have worked to perfection. It is the greatest possible comfort to us in the house to have the light with satisfactorily equal brilliancy at all hours of night or day and every day of the week. I have now cut off the gas at the meter, so that there is absolutely none used in the house. I have no oil lamps, and have not used so much as a single quarter of a candle within the last three months, and I have the electric light in every part of the house where light can possibly be wanted by night or by day. I find by a little management, of throwing off a few cells from the house circuit when the engine is going, and throwing them on when it is stopped, that there is no difficulty in keeping the potential at the house within 2 or 3 per cent. of absolute constancy. I use a Clerk gas engine to drive the dynamo, and find that it is impossible to tell by the appearance of the lights whether the engine is going or not. Before I had your secondary battery we could always see a pulsation of the lights in time with the revolutions of the engine. The absolute steadiness of the light which we now have is most satisfactory and pleasing.

I have six of your cells continually in use on my laboratory table, and they are charged according to need by joining them in parallel and putting them into the charging circuit ; so that when they are being charged the engine is called upon to work against a potential of 45 cells instead of, as usual, a potential of 44 cells. This makes scarcely a sensible difference to the engine ; it merely lets it go a little faster, and causes it to give a slightly smaller current. Of course, a sixth part of this charging current passes through each of the laboratory cells. I use these cells for laboratory purposes, sometimes keeping them joined in parallel and sometimes joining them in series according to my laboratory needs. It is a great convenience to me to be able to get at any moment 180 ampères for testing and adjusting my electrical measuring instruments. With this varied and irregular use in my laboratory the six cells keep in perfectly good order. I suppose if I take care never to run them down too low, they will keep in good order for years.—Yours truly,

(Signed) **William Thomson.**

Electric v. Oil Lamps.

On page 256 of last week's issue under the head of "Lighthouse Illuminants" you say : "There is much contained therein (the *Society of Arts Journal*) of interest to the electrical engineer, the remarks of Mr

R. E. Crompton being very much to the point, for he shows that the electric light can as well be used for a small light as a big one, and that then, instead of being two-and-a-half times dearer than oil, its cost might be reduced to *one-and-half* times less." This certainly is interesting were it not, as I imagine, a misprint; since I for one was not aware that the electric light companies were in so flourishing a condition as to enable them to pay their consumers half the amount of their former oil bill in addition to the advantages of electricity as an illuminant.

Arthur E. Cotterell.

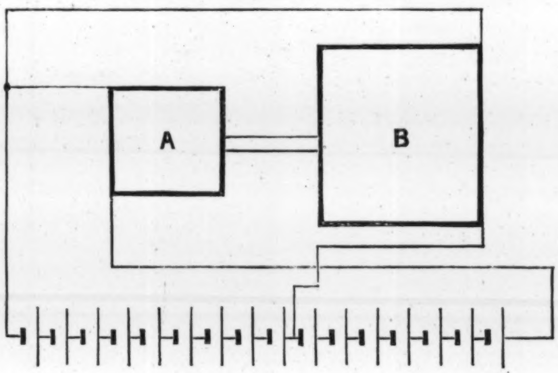
Birmingham, *March 23rd*, 1886.

[Our correspondent apparently mistakes Mr. Crompton's meaning. Surely an arc light can be very economically produced! The subject under discussion was not one dealing with electric light supply companies and consumers generally, but with single arc lamps for special purposes.—EDS. ELEC. REV.]

"Dynamo Tests."

With reference to Lord Rayleigh's suggestion in connection with this subject, I may mention I have for some months employed a method somewhat similar for testing motors, although I have not yet used it for obtaining their efficiency.

A is the motor which is worked by secondary batteries; this is coupled direct to the dynamo, B, the current from which charges some of the cells.



At present the method of experiment is:—1st. The motor is tested with a Prony brake, and the H.P. it gives out at a given speed obtained; it is then connected as shown, and the same speed obtained by varying the number of cells B has to charge. The method was originally devised for running motors for several hours, to test for heating, &c., without much expenditure of energy.

The dynamo is a large one, and had I known its efficiency at different speeds and currents, I should have measured the efficiency of the motor by means of it instead of using the brake. As it is, I hope before long to have a complete calibration of its efficiency, and I shall then do away with the brake.

With this method there is no necessity to have the machines the same.

Herbert W. Butler.

Laboratory, Electrical Power Storage Co.,
Limited, *March 18th*, 1886.

The Electric Meter as a Secondary Battery Indicator.

There is no doubt the method of using one meter in the charging and another in the discharging circuit (and which Sir Thomas S. Bazley mentioned in your last issue) is really the best means we at present have of ascertaining the charge in secondary batteries. I think, however, that a single meter, by varying the direction of its motion with the change in the direction of the current, might be made to show directly the number of ampère-hours in storage. During charging the finger of the meter would advance, receding again in correspondence with the discharge, thus doing mechanically the subtraction sum necessary with two meters. In meters in which the direction of the motion is not dependent on the direction of the current, a reversing clutch might be placed between the meter proper and its counting gear, a magnet or solenoid (permanently magnetic by a local current from the battery) being attached to the lever of the clutch, and acted on by a solenoid in the charging and discharging circuit.

In this way, also, a glance at the meter would at once show the attendant the state of the battery, or by means of contacts on the dial of the meter (the contacts being in connection with suitable relays), the dynamo circuit might be automatically opened, when the battery was charged, and closed again when any predetermined discharge had taken place.

I may add that the electric meter is attaining a simplicity and perfection that quite warrants its use in the above manner.

G. E. Dorman.

Stafford, *March 22nd*, 1886.

Theatre Lighting.

Noticing in your issue of 19th inst. the report of the second year's working of the installation at the Prince's Theatre, we think that you may probably be interested to receive a few particulars regarding our installation at the Theatre Royal in this city. This installation was made in December, 1882, from which time it has worked without the slightest hitch.

In January of last year we were requested to put incandescent lamps in the footlights, in order to do which it was necessary to remove the gas fittings—the confidence of the lessee had not been sufficiently strong to allow this at the outset. The lamps, which are of the Edison type, have been running about 6,000 hours; there are still many of the original ones in use, and none of the renewals have given out yet.

The dynamos are four Edison 250-light machines, which are worked at varying loads as scenic effects may require; during the whole time the commutators have not worn more than $\frac{1}{32}$ in., and the wear of brushes has only been $\frac{7}{8}$ in. each.

In November, 1884, we extended the installation in order to light the Comedy Theatre, which has been done with equal success; and a few months ago we added a large set of Elwell-Parker accumulators for the lighting of a warehouse and a concert hall in the vicinity by means of the same plant.

J. R. Williamson.

Manchester Edison Company,
March 23rd, 1886.

"Dynamo Testing."

In looking over the results, published in your issue of the 12th inst. (p. 230), of the recent tests of the Edison-Hopkinson machines at Manchester, I am somewhat puzzled as to how the method employed can lead, rigorously, to the required determinations of efficiency. My difficulty is entirely distinct from those practical difficulties referred to in the article regarding the measurement of the actual power transmitted by the belt to the shaft. It seems to me that the equations involved always contain at least one unknown quantity more than the method gives data for eliminating, and I should feel greatly obliged if you would kindly indicate how Dr. Hopkinson treats the observations so as to obtain the separate efficiencies of generator and motor.

R. Mullineux Walmsley.

Technical College, Finsbury,
London, E.C., *March 23rd*, 1886.

[Probably Dr. Edward Hopkinson will give Mr. Walmsley the desired information.—EDS. ELEC. REV.]

Secondary Generators.

In the course of the last week Prof. Forbes, as well as some other gentlemen, have ventilated the advantages and disadvantages of connecting inductional transformers for alternating electric currents in multiple arc with the high tension mains.

We are glad to see that some of the writers on this subject agree in their views with those held by us for a considerable time, and also that the scientific side of the question is becoming the object of investigation by men of science. But as to the industrial side of the question we beg to state that the connection of alternating current transformers with their primary coils in multiple arc and supplying same with alternating currents of sensibly uniform tension is the subject of our English patent No. 3379, dated 16th March, 1885, and that the same is patented to us in Germany and in most industrial countries of the world. We are also determined to defend our rights relative to this invention with all the means provided by law.

Charles Zipernowsky.
Max Deri.
Otto Titus Blathy.

Budapest, *March* 18*th*, 1866.

Telephone Patents.—To "Combination."

Edison's claim to "the combination of a diaphragm or tympan with a tension regulator" has been sustained by the Courts in England, and I see no reason to question his right to that combination. What a *diaphragm* or *tympan* is, in a telephone transmitter, has not yet been judicially decided in England.

I shall send for the next REVIEW descriptions and drawings of telephone transmitters—without a diaphragm or tympan, or the shadow of one—which I shall offer free to the public generally.

W. C. Barney.

Washington, No. 917, Sixteenth Street,
March 10*th*, 1886.

American Telephone Patent Litigation.

I herewith send to the REVIEW what purports to be a complete synopsis of the Government Bill in the Bell telephone case. I cannot vouch for its accuracy, and I am inclined to question it, because there are so many allegations against the validity of the patent which I know are not sustained by the evidence before the Secretary of the Interior, all of which I have had an opportunity of reading, through the courtesy of Mr. Jenks, Assistant Secretary of the Interior.

In my comments on this bill I assume that it is the *true* Bill. It is therein stated that "Prof. Bell's application was filed later in the day" than Mr. Gray, who filed a caveat the same day, namely, 14th February, 1876. Now, the fact established by the written documents in the Patent Office was, that Bell's application was filed two hours before Gray filed his caveat. The bill alleges "that Bell claims to be the original and first discoverer of an invention which is called the undulatory current of electricity." This allegation is not true. Bell does not make such a claim; but, on the contrary, he says in his American and English patents such a current and a way of making it has long been known.

It is alleged in the bill that the Examiner, Z. F. Wilbur, communicated to Bell the "wording" of certain parts of Gray's caveat. No evidence of that fact was produced before the Secretary of the Interior, nor is there any evidence to be found in the records of the Patent Office; but there is written evidence that Wilbur did communicate to Gray parts of Bell's specification.

I believe that I have read and heard all the evidence that has been brought forward against the Bell patent of 7th March, 1876, and I am clearly of opinion that, if the bill be as the enclosed document says it is, the court before whom it may be tried will sustain Bell's claim to the use of an undulatory current in a speaking telephone; or, to be more precise, to the use of a *closed* circuit for telephonic purposes.

The bill proposes to question the validity of the Bell patent of 30th January, 1877, which is virtually the claim "to the iron plate held down around its edge in front of, close to, but not touching a pole of a magnet." The fifth claim of this patent is for a "magnet with a coil upon the end or ends of the magnet nearest the plate." This is a claim, *per se*, of such a magnet and coil. Now, unfortunately for Mr. Bell, such a magnet was used by Prof. Hughes in his printing telegraph; descriptions and drawings thereof were published in a work by my friend the late Count Du Moncel, entitled "Traité de Télégraph Electrique," published in 1864, also by Schellen, therefore that claim fails; but fatal to the validity of the whole patent is the fact well established that Bell had in his possession, and consulted a book in which that magnet is described and illustrated, and yet Bell has made oath to having invented that magnet; this invalidates the whole patent.

As to prior inventions of a speaking telephone, I think the court will require satisfactory evidence that prior to Bell's patent of 7th March, 1876, there was a speaking telephone described and published in some printed book. Now, it is well known that there is not any printed book describing a speaking telephone prior to that date, if we except the description of Bourseul's telephone published in a newspaper in Paris on 30th July, 1854.

It is not wise to make predictions, but I will venture to say that Bell will be able to hold under his patent the use of an *undulatory current* or of a closed circuit in a telephone.

W. C. Barney.

Washington, 917, Sixteenth Street,
March 10*th*, 1886.

Prof. Thompson's Valve Telephone.

I noted the remarks of your correspondent "Combination" in your issue of 5th March *re* the Valve Telephone, and also those of Mr. S. F. Walker in your last, and I am sorry to say that our firm had the same unfortunate experience with the New Telephone Company's instruments, as sent out in October of last year. In our case, also, a gentleman was sent down from London to fit them up, but failed to make them work satisfactorily, and after several trials they were sent back.

"Combination" in his letter mentions that an "expert" was sent to fix his firm's instruments; but if this was the same gentleman who waited upon us, he informed us at the time that he had only then been in the employment of the New Telephone Company for about a fortnight. Should I be right in my conjecture, I scarcely think "Combination" is justified in classifying him as an "expert."

The New Telephone Company lately forwarded us a set of their most recent pattern instruments, and on fitting them up over a short metallic circuit we found them to work in an exceedingly satisfactory manner; the articulation being clear and distinct, and not of the "Punch and Judy" type mentioned by "Combination." On the New Telephone Company's Inspector calling two days later, we disconnected them from this line and connected them to a circuit about $\frac{3}{4}$ mile long, and with equally satisfactory results.

Should "Combination" visit Glasgow and favour us with a call, we shall be glad to show him these instruments connected up between our premises here and an office about $\frac{1}{4}$ mile distant, the wire coming in close contact to that of the National Telephone Company.

A. W. Hine.
OF HENRY BENNETT & CO.

45, Bothwell Street, Glasgow,
March 16*th*, 1886.

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